ME-1312

TECHNICAL MANUAL

DATA CONVERTER/-
FM MULTIPLEXER SYSTEM

4900 SERIES
(EMR)

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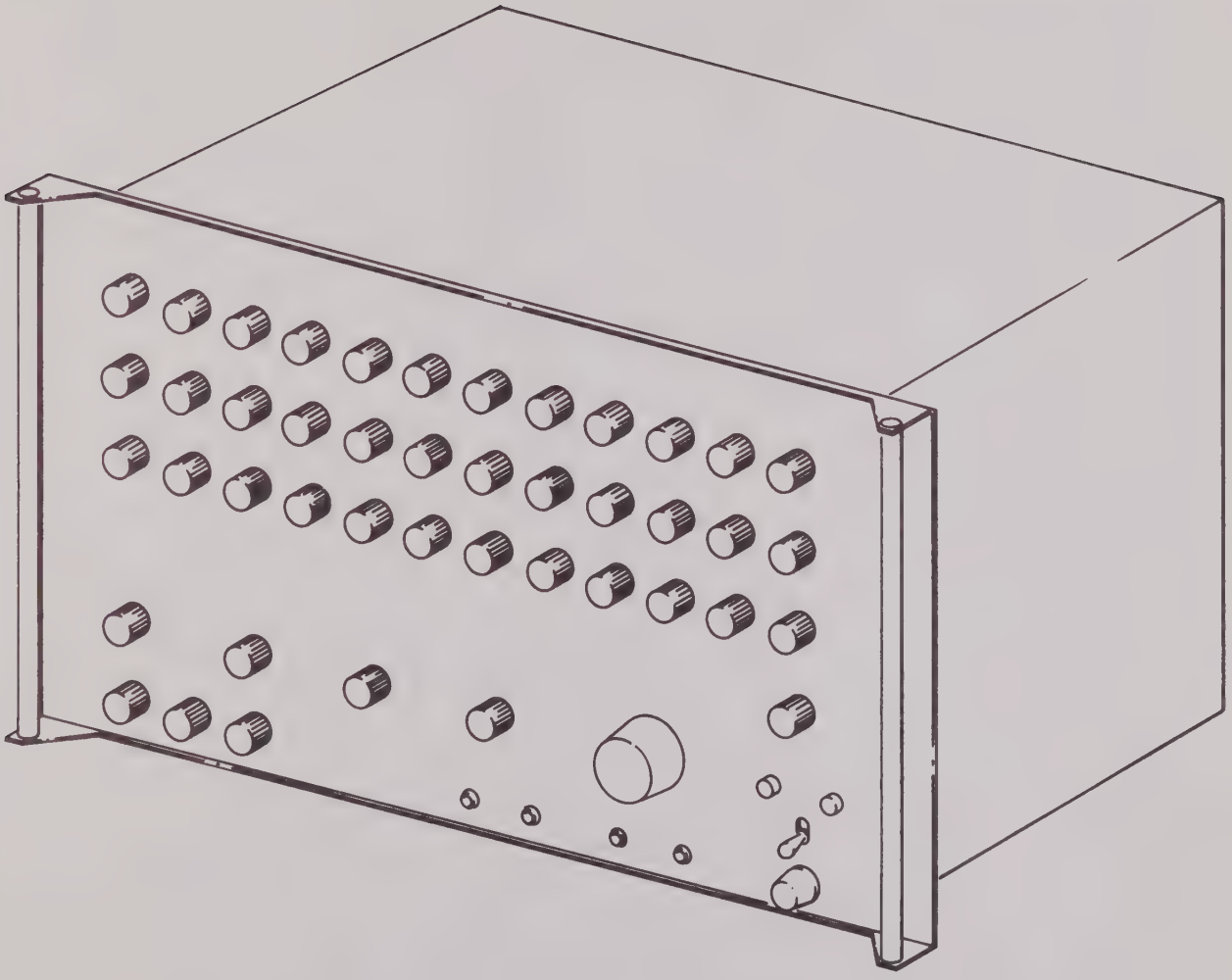
Data Converter/FM Multiplexer System



Data Converter/FM Multiplexer System

Revised August 12, 1970

SECTION 1

EMR DATA CONVERTER/FM MULTIPLEXER SYSTEM

1.1 GENERAL DESCRIPTION

This manual contains instructions for the operation and maintenance of the EMR Data Converter/FM Multiplexer System. The system accepts analog voltage inputs and multiplexes the inputs into groups of FM subcarrier frequencies for application to recording or demultiplexing instruments in FM telemetry systems.

The Data Converter/FM Multiplexer System is a self-contained unit ready for mounting in a standard 19-inch rack. Individual assemblies of the unit include an EMR Model 4900 Drawer Assembly, an EMR Model 4966 Power Supply, and EMR plug-in type modular units. A description of the Model 4900 Drawer Assembly is contained in Paragraph 1.2. The Data Converter/FM Multiplexer System functional description is contained in Paragraph 1.3. Instructions for the EMR Model 4966 Power Supply are contained in Section 2 of this manual. Instructions for the EMR plug-in type modular units are provided in individual manuals contained in Sections 3 through 6.

1.2 EMR MODEL 4900 DRAWER ASSEMBLY

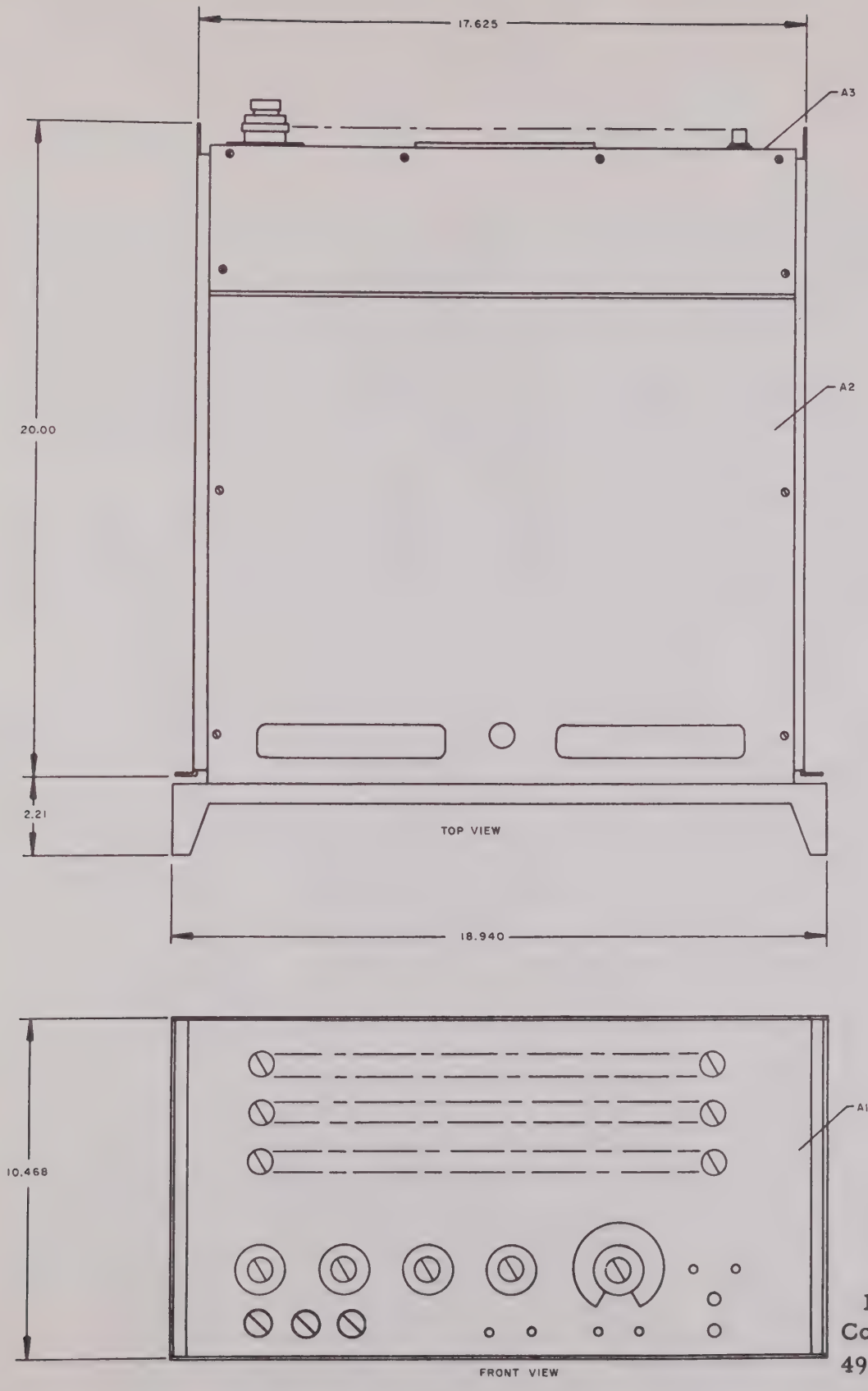
1.2.1 Physical Description

The EMR Model 4900 Drawer Assembly, shown in Figure 1-1, is a slide mounted drawer which mounts in a standard 19-inch rack. The slide mounts installed on both sides of the drawer permit extraction of the drawer from the rack for servicing. Handles on the front are used to extend the drawer from the rack. Turn-to-lock catches on either side of the front panel secure the drawer in the rack.

Top and bottom covers are installed on the drawer to provide radio-frequency shielding. Access to the internal equipments is obtained with drawer extended from the rack by unlatching the quick-disconnect fasteners and raising the hinged cover. Access to the internal wiring is obtained with the drawer removed from the rack by removing mounting screws from the bottom cover and removing the cover.

Major subassemblies of the drawer are assigned assembly (A) designations for identification purposes. The assembly designations are as follows:

A1 - Front Panel
A2 - Main Chassis
A3 - Rear Panel



EMR Drawing Control No. 4900-001

Figure 1-1. EMR Model 4900 Drawer Assembly

Front panel A1 contains operating controls for programming the system to meet particular system-application requirements. An ON-OFF switch controls application of AC power to the power supply. A fuse, mounted on the front panel, provides protection from the AC power source. All front-panel controls, indicators, and monitor jacks are shown in Figure 1-2 and are described in Table 1-1.

Main chassis subassembly A2 is a three-section card file which accommodates up to 57 card locations. The card file contains mounting supports and shield assemblies for the plug-in-type modular units installed in the drawer. The shield assemblies are mechanically mounted on the mounting supports in the bottom of the main chassis. Each shield assembly occupies three card locations and contains three mating connectors for the plug-in modular units. The internal arrangement of the card file and location of plug-in modular units are shown in Figure 1-3, sheet 2 of 3. Mounting facilities for the EMR Model 4966 Power Supply are provided in the rear of the main chassis.

Rear panel A3 contains electrical connectors for all input and output connections to the drawer. A twist-lock power plug is provided for AC power input to the drawer. Internal cooling is provided by a blower mounted vertically on the rear panel. The location of each rear-panel connector and the cooling blower is illustrated in Figure 1-4.

1.2.2 Electrical Description

The Model 4900 Drawer Assembly is prewired to meet particular system requirements. Wiring between subassemblies of the drawer is illustrated in Figure 1-3. All external electrical connections to the drawer are terminated at connectors on the rear panel. The external electrical connections to the rear-panel connectors are listed in Table 1-2.

1.2.3 Specifications

The Model 4900 Drawer Assembly specifications are contained in the following paragraphs.

1.2.3.1 Electrical Specifications

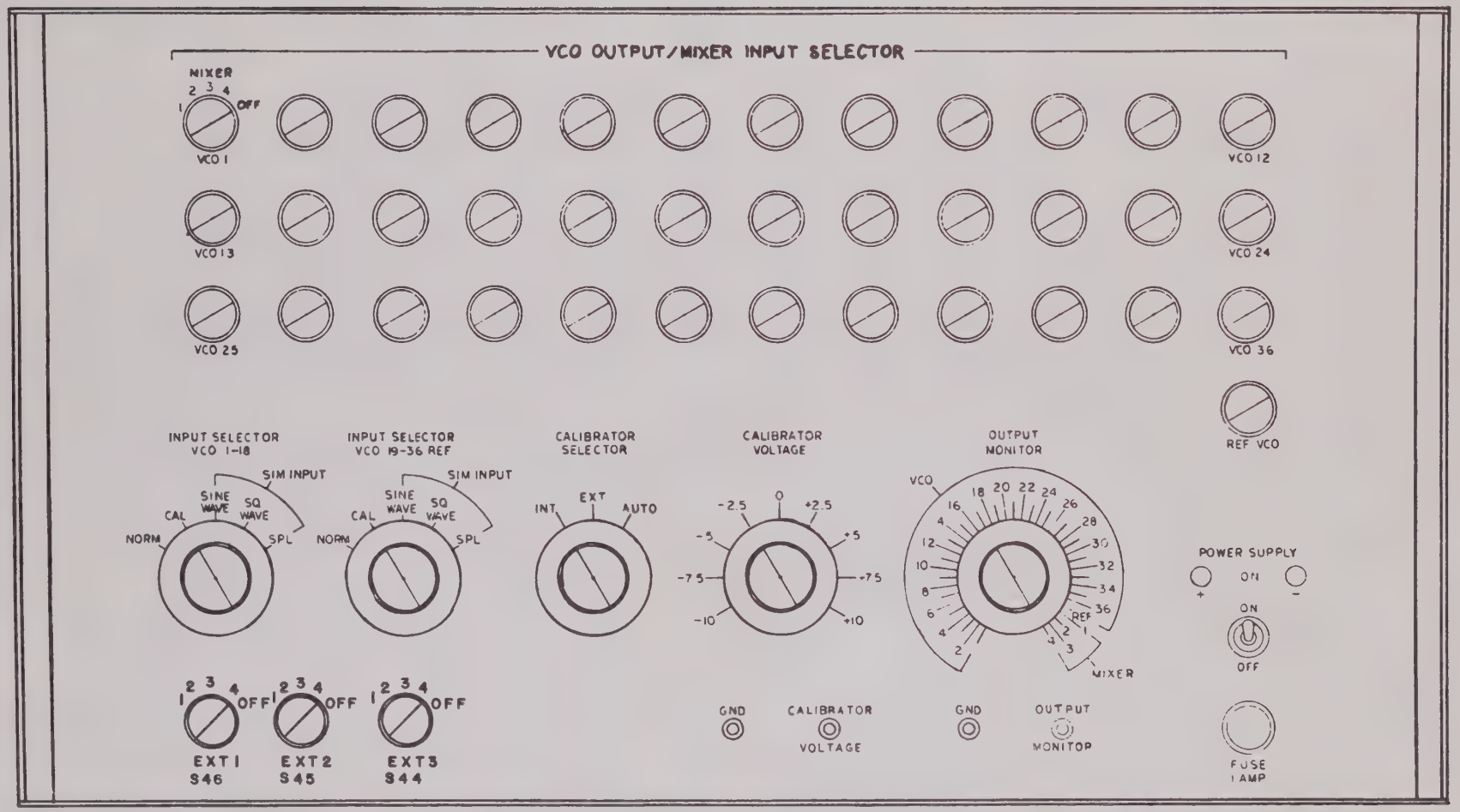
The power input required for drawer operation is 115 volts AC ±10%, 57 to 63 CPS. Nominal power dissipation is 50 watts.

1.2.3.2 Physical Specifications

a. Height: 10-1/2 inches.

b. Width: 17-1/2 inches.

c. Length: 20 inches maximum.



EMR Drawing Control No. 4900-002

Figure 1-2. Location of Front Panel Controls, Indicators and Monitor Jacks

Table 1-1. Function of Front Panel Controls, Indicators and Monitor Jacks (Ref. Figure 1-2)

REF. DESIG.	NAME	FUNCTION
DS1	POWER SUPPLY ON plus (+) indicator	Power Supply plus (+) output status indicator. When lit, indicates plus (+) voltage is present.
DS2	POWER SUPPLY ON minus (-) indicator	Power Supply minus (-) output status indicator. When lit, indicates minus (-) voltage is present.
F1	FUSE	Provides protection from external power source. Located in primary power input line to drawer.
S1	VCO 12 MIXER selection switch	Permits switching of the VCO output, through the 51K mixing resistor on the rear of the switch, to the input of mixers 1, 2, 3, or 4. In OFF position, the VCO output is grounded through the 51K resistor.
S2	VCO 11 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S3	VCO 10 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S4	VCO 9 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S5	VCO 8 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S6	VCO 7 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S7	VCO 6 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S8	VCO 5 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S9	VCO 4 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S10	VCO 3 MIXER selection switch	Same as VCO 12 MIXER selection switch.

Table 1-1 (Cont'd.). Function of Front Panel Controls, Indicators and Monitor Jacks (Ref. Figure 1-2)

REF. DESIG.	NAME	FUNCTION
S11	VCO 2 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S12	VCO 1 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S13	VCO 24 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S14	VCO 23 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S15	VCO 22 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S16	VCO 21 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S17	VCO 20 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S18	VCO 19 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S19	VCO 18 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S20	VCO 17 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S21	VCO 16 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S22	VCO 15 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S23	VCO 14 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S24	VCO 13 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S25	VCO 36 MIXER selection switch	Same as VCO 12 MIXER selection switch.

Table 1-1 (Cont'd.). Function of Front Panel Controls, Indicators and Monitor Jacks (Ref. Figure 1-2)

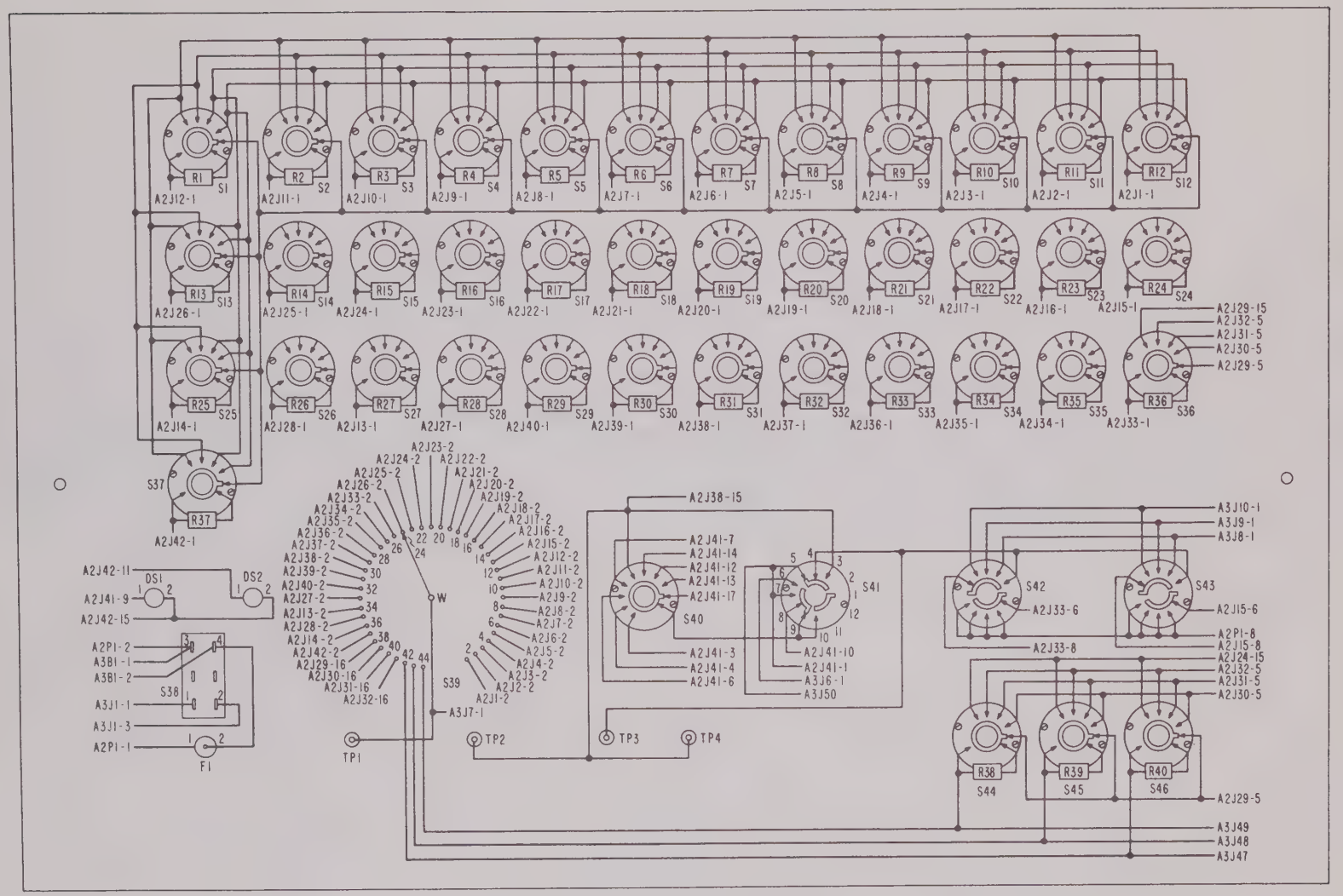
REF. DESIG.	NAME	FUNCTION
S26	VCO 35 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S27	VCO 34 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S28	VCO 33 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S29	VCO 32 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S30	VCO 31 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S31	VCO 30 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S32	VCO 29 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S33	VCO 28 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S34	VCO 27 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S35	VCO 26 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S36	VCO 25 MIXER selection switch	Same as VCO 12 MIXER selection switch.
S37	REF. VCO MIXER selection switch	Same as VCO 12 MIXER selection switch.
S38	ON-OFF switch	Controls application of primary power to power supply.
S39	OUTPUT MONITOR switch	Permits selection of VCO or mixer output to be applied to front panel OUTPUT MONITOR test point TP1 and to rear-panel jack A3J7.

Table 1-1 (Cont'd.). Function of Front Panel Controls, Indicators and Monitor Jacks (Ref. Figure 1-2)

REF. DESIG.	NAME	FUNCTION
S40	CALIBRATOR VOLTAGE switch	Permits selection of calibration voltage to be applied to VCO's during calibration mode.
S41	CALIBRATOR SELECTOR switch	Permits selection of calibrator to be used in calibration mode. Used in conjunction with INPUT SELECTOR VCO 1-18 and 19-36 REF switches. In INT position, selects internal calibrator output. In EXT position, selects external calibrator input at rear-panel connector A2J6. AUTO position not used. Provided for future expansion.
S42	INPUT SELECTOR VCO 19-36 REF switch	Permits selection of input to VCO's 19 through 36 and REF. VCO. In NORM position, individual inputs from rear-panel connectors are applied to VCO's 19 through 36 and REF VCO input is grounded. In CAL position, the selected voltage, per the positioning of switches S40 and S41, is applied to the inputs of VCO's 19 through 36 and the REF VCO. In SINE WAVE, SQ WAVE, or SPL positions, inputs are applied from an external source through rear-panel connectors to VCO's 19 through 36 and the REF VCO.

Table 1-1 (Cont'd.). Function of Front Panel Controls, Indicators and Monitor Jacks (Ref. Figure 1-2)

REF DESIG.	NAME	FUNCTION
S43	INPUT SELECTOR VCO 1-18 switch	Permits selection of input to VCO's 1 through 18. In NORM position, individual inputs from rear-panel connections are applied to VCO's 1 through 18. In CAL position, the selected voltage, per the positioning of switches S40 and S41, is applied to the inputs of VCO's 19 through 36 and the REF VCO. In SINE WAVE, SQ WAVE, or SPL positions, inputs are applied from an external source through rear-panel connectors to VCO's 1 through 18.
S44	EXT 3 mixer selection switch	Permits switching of the external VCO output, through the 51K mixing resistor on the rear of the switch, to the input of mixers 1, 2, 3, or 4. In OFF position, the VCO output is grounded through the 51K resistor.
S45	EXT 2 mixer selection switch	Same as EXT 3 mixer selection switch.
S46	EXT 1 mixer selection switch	Same as EXT 3 mixer selection switch.
TP1	OUTPUT MONITOR	Monitoring jack for output as selected by OUTPUT MONITOR switch S39.
TP2	GND	Ground
TP3	CALIBRATOR VOLTAGE	Monitor jack for calibration voltage output as selected by CALIBRATOR VOLTAGE switch S40 and CALIBRATOR SELECTOR switch S41.
TP4	GND	Ground



FRONT PANEL - INSIDE VIEW (NOT DRAWN TO SCALE)

NOTES:

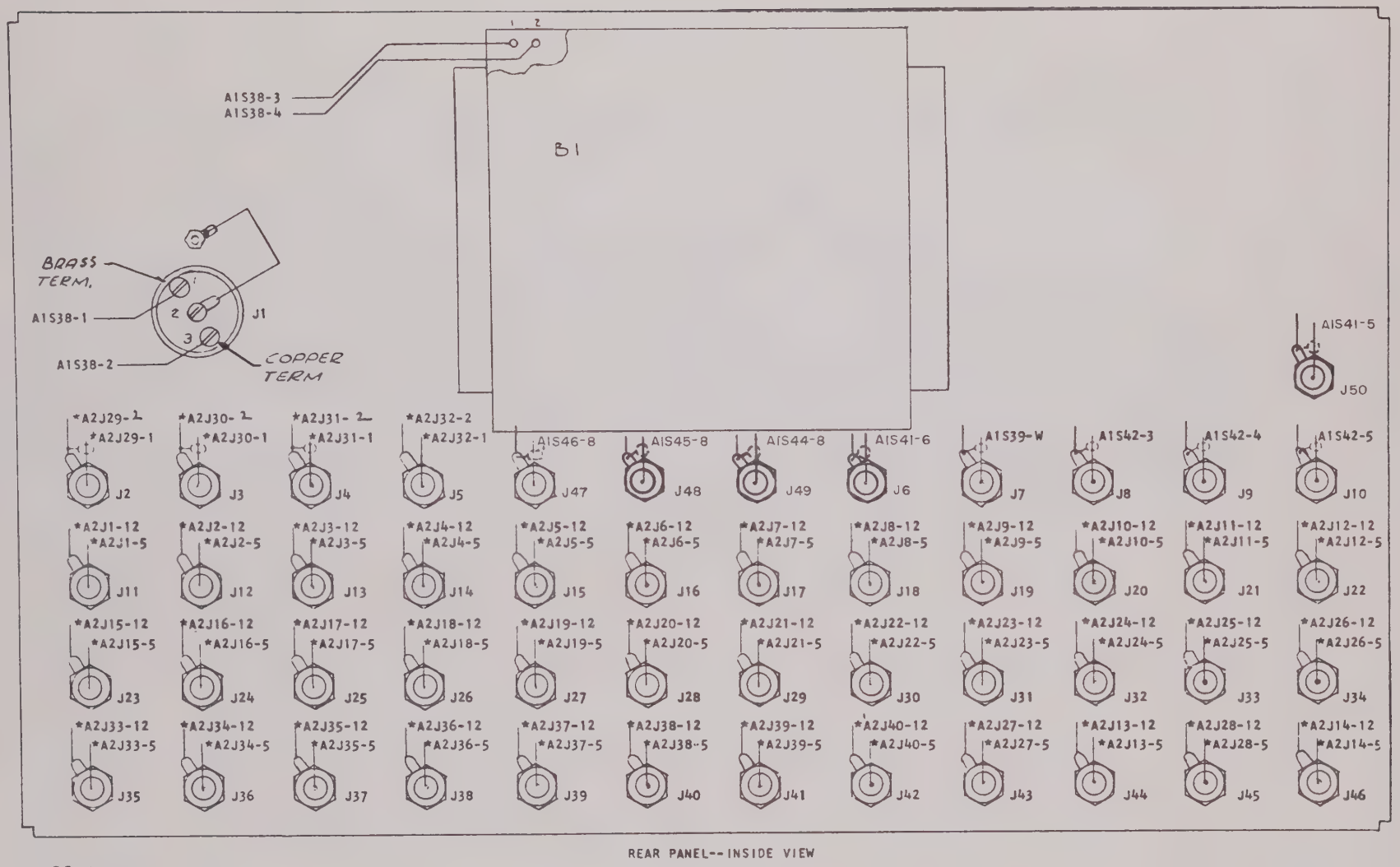
1. INTERSWITCH WIRING FOR SWITCHES S13 THROUGH S24 AND S25 THROUGH S36 IS THE SAME AS SHOWN FOR S1 THROUGH S12.
2. EMR DWG CONTROL NO. 4900-003.
3. TYPICAL OF SWITCHES S1 THROUGH S37 AND S40 THROUGH S46:

Figure 1-3. Model 4900 Drawer, Assembly and Wiring Diagram (Sheet 1 of 3)

CARD FILE A2--BOTTOM VIEW

NOTES:
1. ALL WIRING FROM PINS 3 AND 4 OF ONE CONNECTOR TO PINS 3 AND 4 OF ANOTHER CONNECTOR IS A TWISTED PAIR.
2. CONNECT PIN 7 TO PIN 17 AND PIN 14 TO PIN 18 ON ALL CONNECTORS EXCEPT A2-J29, A2-J30, A2-J31, A2-J32, A2-J41, AND A2-J42.
3. ⊕--TWO PINS ON SAME CONNECTOR WHOSE ADDRESSES ARE PREFIXED BY ~~###~~ ARE A TWISTED SHIELDED PAIR.
4. EMR DRAWING CONTROL NO. 4900-010.

Figure 1-3. Model 4900 Drawer, Assembly and Wiring Diagram (Sheet 2 of 3)



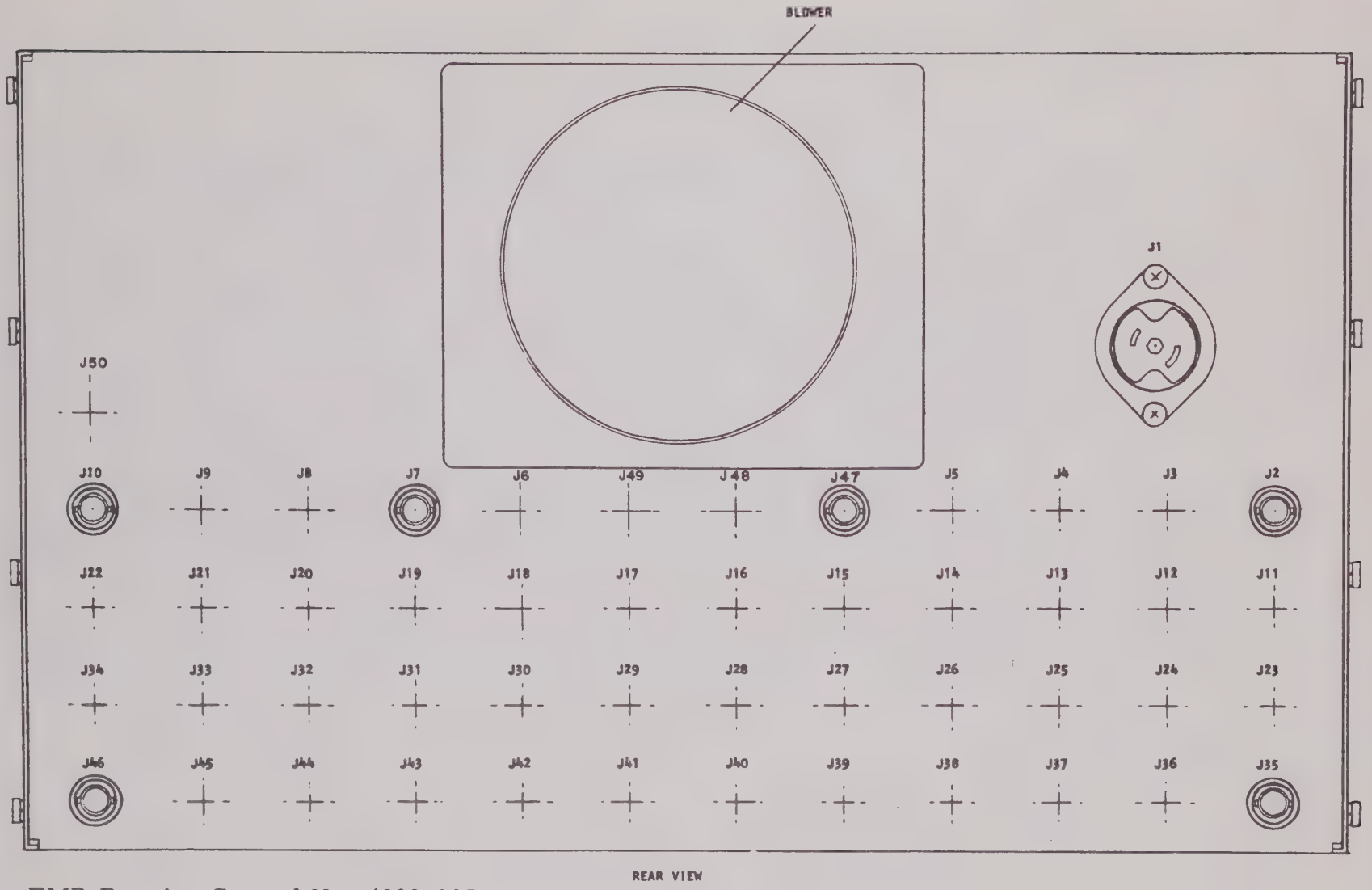
Notes:

* Twisted shielded pair.

1. EMR Dwg. Control No. 4900-004.

KEY:

Figure 1-3. Model 4900 Drawer, Assembly and Wiring Diagram (Sheet 3 of 3)



EMR Drawing Control No. 4900-005

Figure 1-4. Location of Rear Panel Connectors and Blower

Table 1-2. External Electrical Connections (Ref. Figure 1-4)

CONNECTOR	FUNCTION
J1	Primary power input to drawer
J2	Mixing amplifier 1 output
J3	Mixing amplifier 2 output
J4	Mixing amplifier 3 output
J5	Mixing amplifier 4 output
J6	External calibration input
J7	Output monitor jack
J8	Sine wave input
J9	Square wave input
J10	Special input
J11	VCO No. 1 input
J12	VCO No. 2 input
J13	VCO No. 3 input
J14	VCO No. 4 input
J15	VCO No. 5 input
J16	VCO No. 6 input
J17	VCO No. 7 input
J18	VCO No. 8 input
J19	VCO No. 9 input
J20	VCO No. 10 input
J21	VCO No. 11 input
J22	VCO No. 12 input
J23	VCO No. 13 input
J24	VCO No. 14 input
J25	VCO No. 15 input
J26	VCO No. 16 input
J27	VCO No. 17 input
J28	VCO No. 18 input
J29	VCO No. 19 input
J30	VCO No. 20 input
J31	VCO No. 21 input
J32	VCO No. 22 input
J33	VCO No. 23 input
J34	VCO No. 24 input
J35	VCO No. 25 input
J36	VCO No. 26 input
J37	VCO No. 27 input
J38	VCO No. 28 input
J39	VCO No. 29 input
J40	VCO No. 30 input
J41	VCO No. 31 input
J42	VCO No. 32 input
J43	VCO No. 33 input
J44	VCO No. 34 input
J45	VCO No. 35 input
J46	VCO No. 36 input

Table 1-2 (Cont'd.). External Electrical Connections (Figure 1-4)

CONNECTOR	FUNCTION
J47	EXT 1 input
J48	EXT 2 input
J49	EXT 3 input
J50	CAL voltage output

1.2.3.3 Environmental Specifications

The drawer assembly and all internal equipments shall operate at temperatures from 0° C to +52° C.

1.2.4 Parts List

The Model 4900 Drawer Assembly parts list is contained in Table 1-3. Parts information is presented in tabular from and is keyed to reference designations of electrical components contained on the major subassemblies of the drawer.

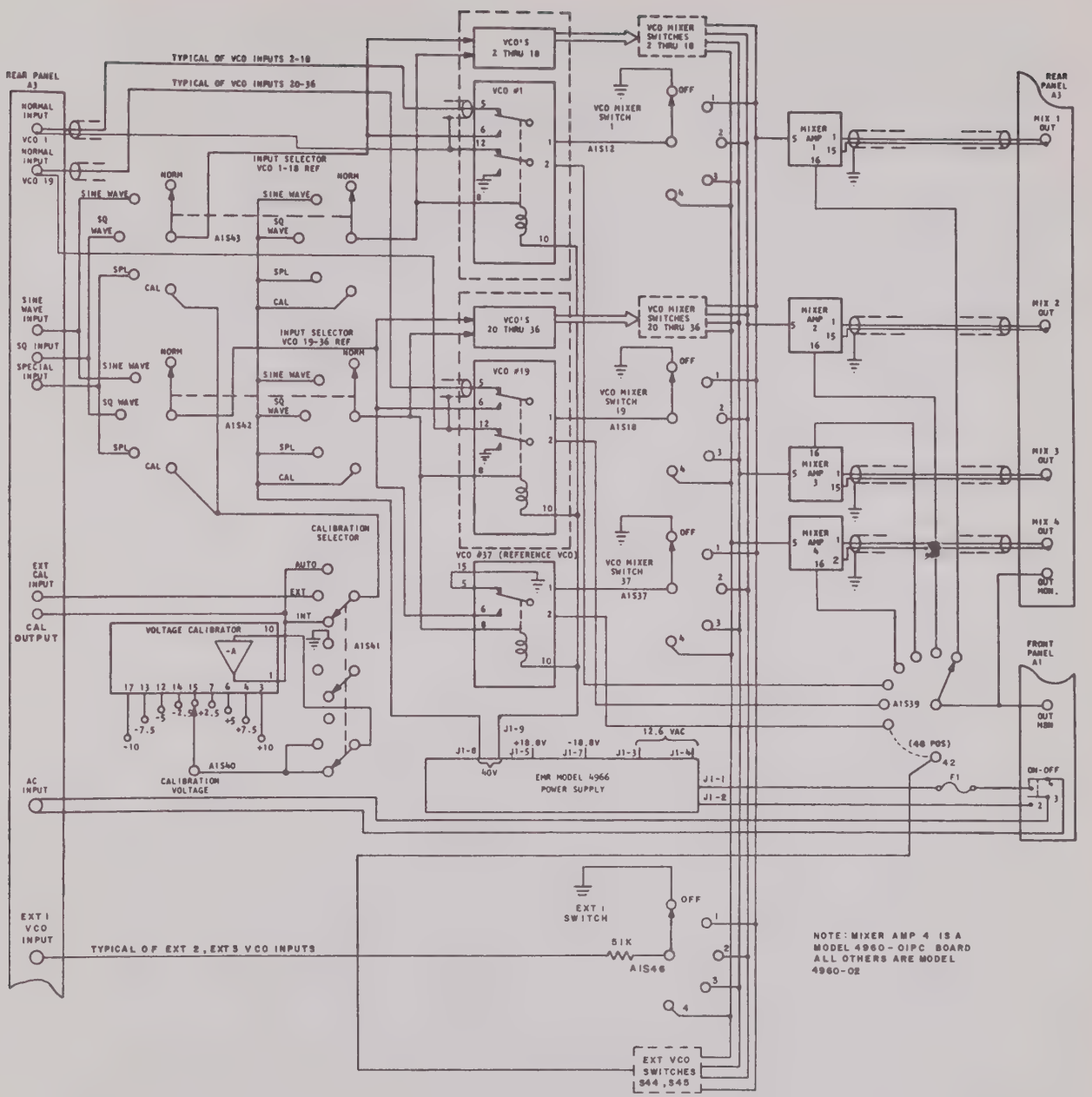
The parts list table is divided into the following columns: Ref. Desig., providing the reference designation of the subassembly or component; Description, providing a complete description of the item; and Manufacturer, providing the name and manufacturer's part number.

1.3 DATA CONVERTER/FM MULTIPLEXER FUNCTIONAL DESCRIPTION

The Data Converter/FM Multiplexer contains 36 VCO's (one for each data source, a 100-Kc reference VCO, input jacks for three external VCO's, four mixing amplifiers, a precision voltage calibrator, a power supply, and associated front-panel switching circuitry. When operating in the normal mode, the system receives data inputs from external sources. When operating in the system checkout mode, the system receives inputs from an external signal simulator or a voltage calibrator. Circuit operation in these two modes is described in the following paragraphs. Figure 1-5 is a block diagram of the system and should be used with the discussion.

1.3.1 System Operation in Data Mode

In the data mode of operation, the front-panel INPUT SELECTOR switches are set to the NORM (normal input) position. The system receives 36 analog data inputs which are routed to the 36 data VCO's. These signals frequency modulate the data VCO subcarrier frequencies, and the resulting FM outputs are fed via VCO OUTPUT/MIXER INPUT SELECTOR switches 1-36 to four mixing amplifiers. The system also has the capability for receiving outputs from three external VCO's. The VCO OUTPUT/MIXER INPUT SELECTOR switches 1-36 and EXT VCO mixer switches 44-46 are wired so that various combinations of VCO outputs may be routed to the mixing amplifiers. The reference VCO (VCO no. 37) provides a 100-Kc output which is used as a reference frequency to be multiplexed with the data VCO outputs for tape-speed compensation. This signal may be applied to one of the mixing amplier inputs as selected at front-panel REF VCO switch S37. The inputs to the mixing amplifiers are linearly mixed, and the resultant multiplexes are amplified and applied as low-impedance outputs to drive external recorders or demultiplexing equipment. Outputs of the data VCO's, the external VCO's, the reference VCO, and the mixing amplifiers may be observed at OUTPUT MONITOR test points on the front and rear panels by selecting the desired output at the front-panel OUTPUT MONITOR switch, S39.



EMR DRAWING CONTROL NO. 4900-006

Figure 1-5. Data Converter/FM Multiplexer System, Block Diagram

1.3.2 Circuit Operation in System Checkout Mode

In the system checkout mode of operation, the front-panel INPUT SELECTOR switches S42 and S43 are set to the CAL, SINE WAVE, SQ (square) WAVE, or SPL (special) positions, depending upon the test sequence being run. With switches in the CAL positions, DC calibration voltages from an internal or external voltage calibrator are applied to the VCO inputs and to the CAL output jack. For the internal voltage calibrator, the calibration input voltage is selected by front-panel CALIBRATOR VOLTAGE selector switch.

With switches S42 and S43 in the SINE WAVE, SQ WAVE, or SPL positions, system inputs are received from an external signal simulator and are routed through the INPUT SELECTOR switches to the 37 VCO's. To test the external VCO circuits, an external signal of 100-Kc (sine wave) is applied to each of the three EXT VCO input jacks. Circuit operation is identical to that described in paragraph 1.3.3 with the exception that the Reference VCO No. 37 will deviate in accordance with the input from the external signal simulator.

Table 1-3. Parts List, Model 4900 Drawer Assembly

REF. DESIG.	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART NO.
	MODEL 4900 DRAWER ASSEMBLY	EMR	7800
	FRONT PANEL	EMR	7799
	KNOB (Used on switches S1 through S37)	EMR	7509
	KNOB (Used on switches S39 through S43)	Raytheon	90-3-26
	KNOB (Used on switches S44 through S46)	Raytheon	MS91528 1D2B
A1	SUBPANEL SUBASSEMBLY	EMR	7804
DS1 and DS2	LAMP, C-lite	Eldema	CF4-GC-1762
F1	FUSE, 1 Amp	Buss	3AG
R1 thru R40	RESISTOR, 51K ±5%, 1/4W	Allen Bradley	RC07GF 513J
S1 thru S37	SWITCH, Rotary, wafer	EMR	6928
S38	SWITCH, Toggle, DPST	Cutler Hammer	8823-K6
S39	SWITCH, Rotary, wafer	Daven	113-DM-41
S40	SWITCH, Rotary, wafer	EMR	6933
S41	SWITCH, Rotary, wafer	EMR	6932
S42 and S43	SWITCH, Rotary, wafer	EMR	6931
S44 thru S46	SWITCH, Rotary, wafer	EMR	6928
TP1 and TP4	TEST POINT	E. F. Johnson	105-251-1
XDS1 and XDS2	LAMP SOCKET	Eldema	2K
XF1	FUSE HOLDER	Buss	HMB
	SHIELD ASSEMBLY	EMR	7801
A2J1 thru A2J42	CONNECTOR, Receptacle	AMP	67074-2
A2P1	CONNECTOR, Plug	Amphenol	126-221
A3	REAR PANEL SUBASSEMBLY	EMR	
J1	CONNECTOR, Jack	Hubbel	7486
J2 thru J50	CONNECTOR, BNC	Automatic Metal Products	UG-1094 A/U
P1	CONNECTOR, Plug (Mating connector for J1)	Hubbell	7484
	BLOWER, Whisper grille fan	Rotron	Muffin-Gold Seal
	POWER PLUG AND CORD	Belden	17408SJ

EMR MODEL 4966

POWER SUPPLY

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EMR MODEL 4966

POWER SUPPLY

1. DESCRIPTION

The EMR Model 4966 Power Supply, shown in Figure 1, operates on 115-volt AC, 60-cycle input power and provides regulated outputs of plus and minus 18.8 volts DC and unregulated outputs of 40 volts DC and 12.6 volts AC. The power supply unit is a self-contained unit requiring only the application of primary power for operation. Current-limiting circuits in each voltage regulator circuit protect the regulated plus and minus 18.8-volt DC outputs from overload or accidental short circuit. All connections to the power supply are made through a single connector on the top surface of the power supply.

The power supply consists of three independent power supply circuits assembled on a main chassis assembly. Two power supply circuits provide separate unregulated 40-volt DC inputs to the plus and minus 18.8-volt DC regulator circuits located on a single printed-circuit assembly. Each unregulated 40-volt DC power supply circuit consists of a step-down transformer, a full-wave bridge rectifier, and a filter capacitor. The unregulated 40-volt DC power supply circuit providing the input to the plus 18-volt DC regulator circuit also provides the unregulated 40-volt DC output applied to the power supply assembly connector. The third power supply circuit consists of a single step-down transformer which provides the unregulated 12.6-volt AC output.

The three step-down transformers, two filter capacitors, and two series-transistor heat-sink assemblies are mounted to the top surface of the main chassis A1. The two full-wave bridge rectifier assemblies and the voltage regulator card assembly, A2, are mounted to the under surface of the main chassis. Wiring connections are made to E pins on the voltage-regulator card, the main chassis, and on the series-transistor heat-sink assemblies. Figure 1 illustrates all major power supply components and the function of each component is described in Table 1.

2. SPECIFICATIONS

The following paragraphs provide the electrical, physical, and environmental specifications for the EMR Model 4966 Power Supply.

2.1 Electrical Specifications

a. Input Power: Approximately 50 watts at 115VAC ±10%, 57 to 63 CPS, single phase.

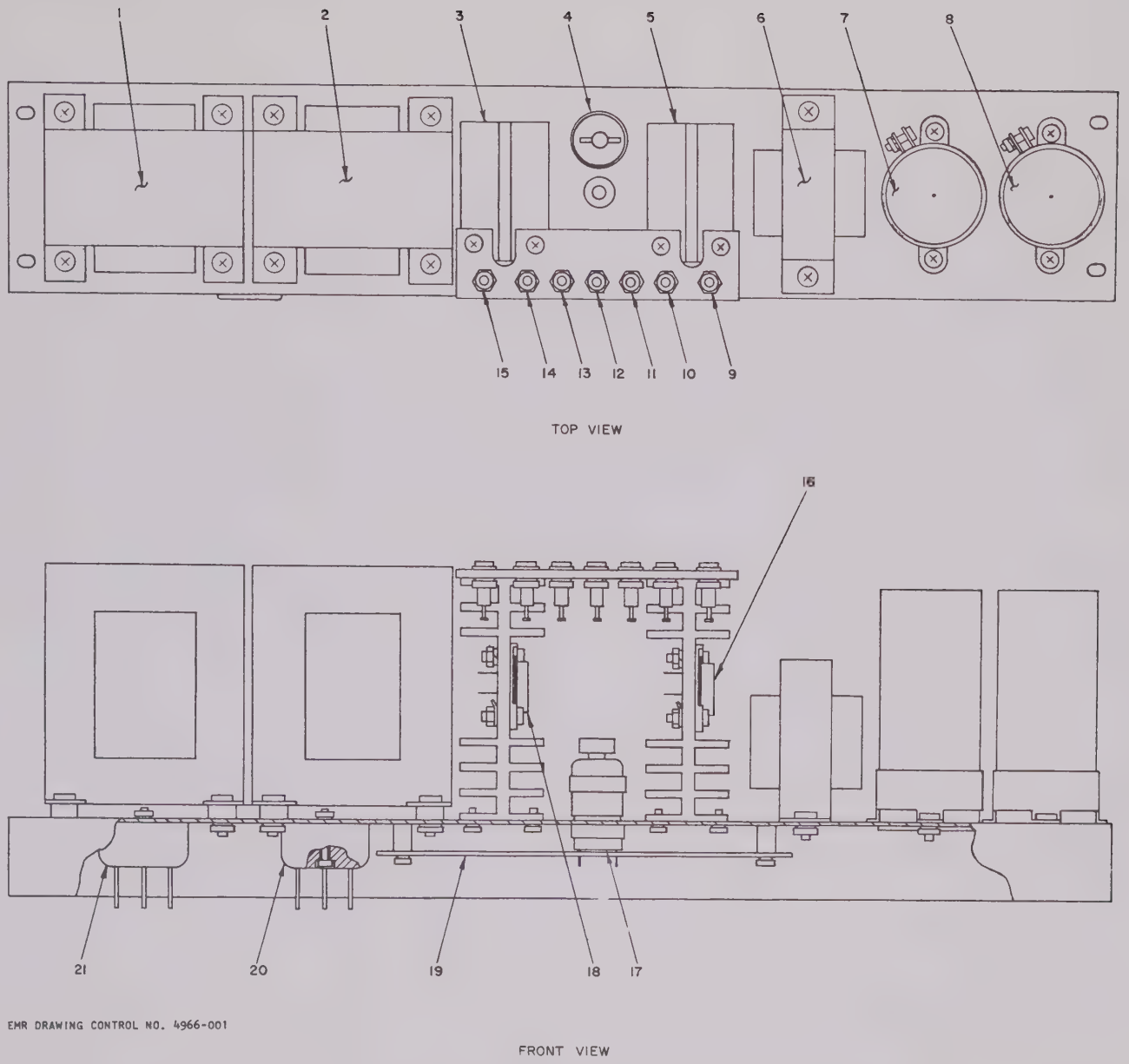


Figure 1. EMR Model 4966 Power Supply, Subassemblies and Major Components (Ref. Table 1)

Table 1. EMR Model 4966 Power Supply, List of Subassemblies and Major Components

REF. NO.	NAME	REF. DESIG.	FUNCTION
1	Step-Down Transformer	A1T1	Steps 115-volt, 60-cycle AC input power down to 26 volts RMS.
2	Step-Down Transformer	A1T2	Steps 115-volt, 60-cycle AC input power down to 26 volts RMS.
3	Series Transistor Heat-Sink Assembly	--	Dissipates heat generated by series transistor A1Q1.
4	Cable Connector	A1P1	Cable connector supplied to mate with chassis-mounted connector A1J1.
5	Series Transistor Heat-Sink Assembly	--	Dissipates heat generated by series transistor A1Q2.
6	Step-Down Transformer	A1T3	Steps 115-volt, 60-cycle input power down to 12.6 VAC.
7	Filter Capacitor	A1C1	Provides ripple filtering for DC output from full-wave bridge rectifier A1CR1.
8	Filter Capacitor	A1C2	Provides ripple filtering for DC output from full-wave bridge rectifier A1CR2.
9	Test-point jack	A1TP1	Monitoring point for regulated +18.8-volt DC output.
10	Test-point jack	A1TP2	Ground.
11	Test-point jack	A1TP3	Monitoring point for regulated -18.8-volt DC output.
12	Test-point jack	A1TP4	Monitoring point for unregulated 12.6-volt AC output when referenced to A1TP5.
13	Test-point jack	A1TP5	Monitoring point for unregulated 12.6-volt AC output when referenced to A1TP4.

Table 1 (Cont'd.). EMR Model 4966 Power Supply, List of Subassemblies and Major Components

REF. NO.	NAME	REF. DESIG.	FUNCTION
14	Test-point jack	A1TP6	Monitoring point (+) for unregulated +40-volt DC output when referenced to A1TP7.
15	Test-point jack	A1TP7	Monitoring point (-) for unregulated +40-volt DC output when referenced to A1TP6.
16	Series Transistor	A1Q2	Functions as part of the -18-volt regulator circuit.
17	Connector	A1J1	Provides interfacing connections between primary power and power supply and between power supply and load.
18	Series Transistor	A1Q1	Functions as part of +18-volt DC regulator circuit.
19	Voltage Regulator Card Assembly	A2	Contains plus and minus 18-volt regulator circuits used to drive chassis-mounted series transistors A1Q1 and A1Q2 respectively.
20	Full-Wave Bridge Rectifier Assembly	A1CR2	Provides full-wave rectification of 26-volts RMS output from A1T2.
21	Full-Wave Bridge Rectifier Assembly	A1CR1	Provides full-wave rectification of 26-volts RMS output from A1T1.

b. Output Voltages:

1. Regulated plus 18.8-volt DC output --
   Voltage: +18.8 volts DC ±5%.
   Current: 1 ampere maximum.
   Ripple: 5 millivolts, RMS maximum.

2. Regulated minus 18.8-volt DC output --
   Voltage: ±18.8 volts DC ±5%.
   Current: 1 ampere maximum.

3. Unregulated 40-volt DC output --
   Voltage: +40 volts DC unloaded.
   Current: 1.5 amperes maximum.
   Ripple: 3 volts RMS, maximum at 1.5 amperes.

4. Unregulated 12.6-volt AC output --
   Voltage: 12.6 volts AC ±10%.
   Current: 1.5 ampere maximum.

2.2 Physical Specifications

a. Length: 14 inches.

b. Width: 3-1/2 inches.

c. Height: 4-7/8 inches.

2.3 Environmental Specifications

The power supply shall operate at rated output and load between 0°C and +52°C without degradation of performance.

3. THEORY OF OPERATION

The following paragraphs provide a functional description of the three power supply circuits comprising the EMR Model 4966 Power Supply. The operation of the various power supply circuits is described with reference to the schematic diagram shown in Figure 2.

3.1 Unregulated +40 VDC and Regulated +18.8 VDC Power Supply Circuits

The unregulated plus 40-volt DC and regulated plus 18.8-volt DC power supply circuits consist of step-down transformer A1T1, full-wave bridge rectifier assembly A1CR1, filter capacitor A1C1, chassis-mounted series-transistor A1Q1, and the plus 18.8-volt DC regulator circuit on the voltage regulator card assembly, A2.

Step-down transformer T1 and its associated rectifier and filter, provides an unloaded unregulated output of 40-volts DC nominal between connector pin A1J1-8 and A1J1-9. The negative side of the rectifier filter applied to A1J1-9 is grounded through resistor A2R7 on the voltage regulator card assembly. The +40-volt DC output is applied directly to A1J1-9 and through chassis-mounted series transistor A1Q1 to A1J1-5. The unregulated 40-volt DC current available at A1J1-5 is equal to 1.5 amperes maximum.

Chassis-mounted series-transistor A1Q1 is an emitter-follower which regulates the DC output at A1J1-5 by controlling the series resistance in the positive side of the supply. The base of series-transistor A1Q1 is clamped at approximately +19.3 volts DC by zener diode A2CR2 and emitter-follower A2Q2 on the voltage-regulator-card assembly, thereby regulating the output of the emitter of chassis-mounted series-transistor A1Q1 at approximately +18.6 volts DC.

Zener diode A2CR1 and transistor A2Q1 on the voltage regulator card assembly, comprise a constant-current source which provides a constant current of 20 milliamperes through zener diode A2CR2. In addition, the high collector resistance of A2Q1 provides a high degree of ripple rejection to zener diode A2CR2.

Transistor A2Q3 is connected in parallel with zener diode A2CR2 to protect the power supply against overloading or accidental short circuiting. Transistor A2Q3 is back biased by A2R7 and has no effect on the regulator circuit during normal operation. Since emitter resistor A2R7 is in series with the power supply output, the current drawn by the external load causes a voltage drop across resistor A2R7 decreasing the reverse bias on transistor A2Q3. When the load current reaches one ampere, the 0.6-volt drop across resistor A2R7 turns on transistor A2Q3 and current is shunted around zener diode A2CR2. As current increases through transistor A2Q3, zener diode A2CR2 cuts off and the voltage at the base of emitter-follower A2Q2 decreases. As current through emitter-follower A2Q2 decreases, conduction through chassis-mounted series transistor A1Q1 also decreases, thereby limiting the current available to the external load at one ampere.

3.2 Regulated -18.8 VDC Power Supply Circuits

The regulated minus 18.8-volt DC power supply circuits consist of step-down transformer A1T2, full-wave bridge rectifier assembly A1CR2, filter capacitor A1C2, chassis-mounted series transistor A1Q2, and the minus 18.8-volt DC regulator circuit on the voltage regulator card assembly, A2. The operation of the minus 18.8-volt regulator circuit is identical to that of the plus 18.8-volt DC regulator circuit except the positive output terminal of the regulator is grounded. See Paragraph 3.1 for a description of voltage regulator operation.

3.3 Unregulated 12.6 VAC Power Supply Circuits

The 12.6-volt AC output is provided between A1J1-3 and A1J1-4 by step-down transformer A1T3. The maximum current available from this output is one ampere. The center tap of the transformer secondary is grounded at chassis pin E4 to provide 6.3-volt AC outputs at A1J1-3 and A1J1-4 when these points are referenced to ground.

4. MAINTENANCE

This paragraph contains information to aid in the troubleshooting and maintenance of the EMR Model 4966 Power Supply. This information is intended to be used in conjunction with the theory of operation contained in Paragraph 3, so that maintenance may be performed with maximum efficiency.

In the event a malfunction occurs, the following method of troubleshooting and repairing is recommended.

a. Disconnect power supply from primary power source and from any external load.

b. If necessary for inspection of maintenance, remove power supply from drawer or mounting assembly.

c. Perform visual inspection (Paragraph 4.1).

d. Perform unit test procedures to aid in localizing the malfunction to either the transformer-rectifier components or the voltage-regulator printed-circuit-card assembly (Paragraph 4.2). Refer to schematic diagram, Figure 2.

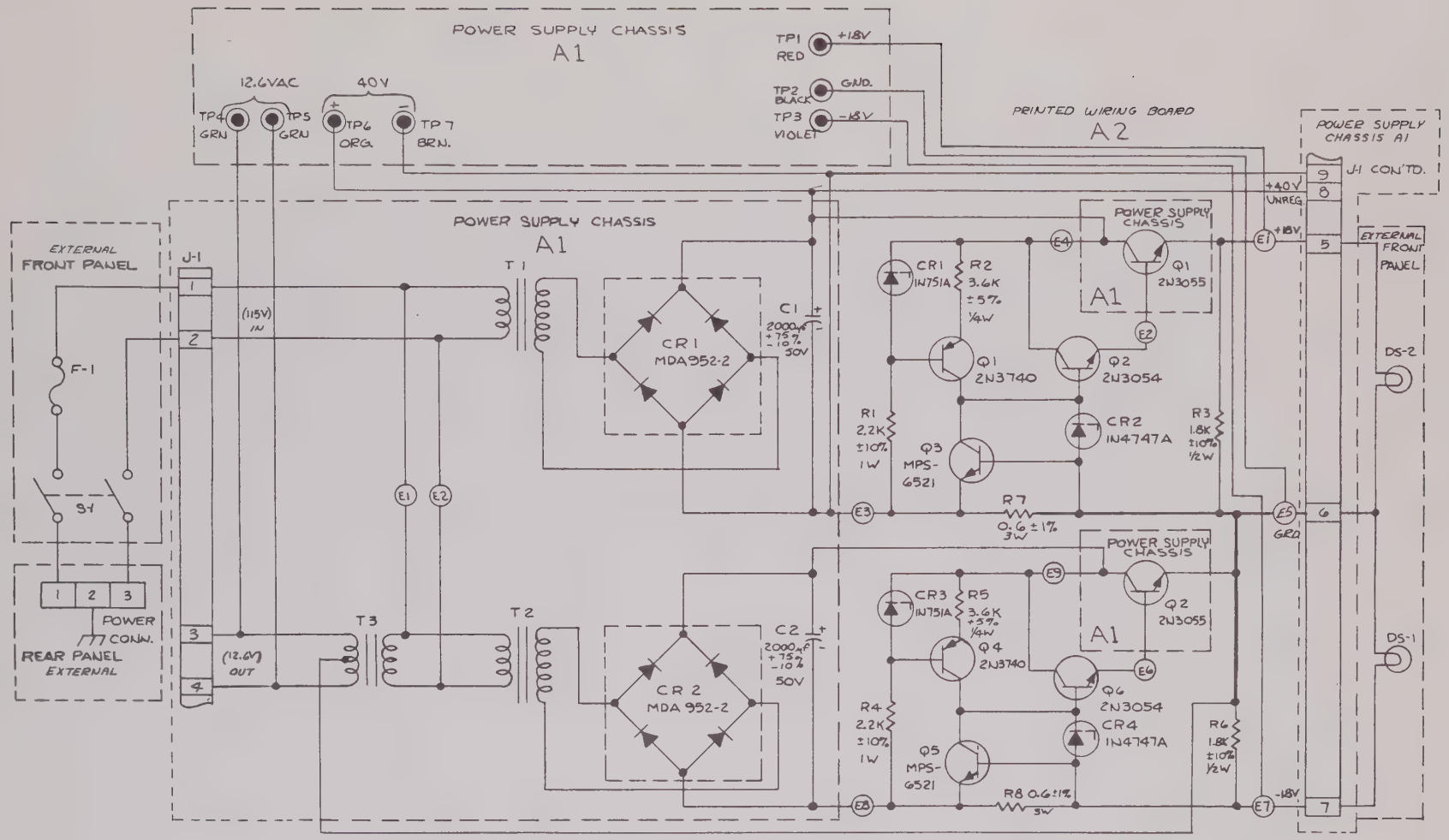
e. If malfunction is localized to a transformer, rectifier assembly, or filter capacitor, refer to Paragraph 5 for component description.

f. If malfunction is localized to the voltage regulator card assembly, troubleshoot card using schematic diagram, Figure 2, voltage regulator component location diagram, Figure 3, and the transistor voltages provided in Paragraph 4.3. After defective component has been located, refer to Paragraph 5 for component description.

g. After repair has been accomplished, repeat unit test procedures (Paragraph 4.2).

4.1 Inspection

The EMR Model 4966 Power Supply should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment.



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000), UNLESS OTHERWISE SPECIFIED.
2. EMR DRAWING NO. 7792.

Figure 2. Schematic Diagram, EMR Model 4966 Power Supply

The following inspection should be performed periodically as a means of preventive maintenance.

a. Shut off input power and remove cable connector to receptacle A1J1 on the power supply chassis. Inspect receptacle J1 for bent or burned contacts. Reinsert cable connector and ensure that connector mates securely with chassis connector.

b. Inspect wiring for loose connections.

c. Ensure that series-transistors A1Q1 and A1Q2 are in firm physical contact with their respective heat-sink assemblies.

d. Inspect chassis components, series transistors, and voltage regulator card components for mechanical damage and for component discoloration caused by overheating.

4.2 Unit Test Procedures

The unit test procedures are intended to aid in localizing trouble in the power supply or voltage regulator circuits. The test procedures first check the output level and ripple of the unregulated output voltages under load and then check the loaded output level and ripple of the two regulated DC output voltages. An overload test procedure is provided to check the operation of the current limiting circuits in each regulator circuit.

Perform unit test procedure as follows:

a. Check unregulated +40-volt DC power supply circuits as follows:

   1. Apply 115-volts, 60-cycle power between A1J1-1 and A1J1-2 on power supply chassis.

   2. With VTVM, measure DC voltage between A1TP6 and A1TP7. Measured DC voltage shall be +40 volts DC nominal.

   3. With RMS voltmeter, measure AC ripple voltage between A1TP6 and A1TP7. Measured AC ripple voltage shall be no greater than 3.0 volts RMS.

b. Check unregulated 40-volt DC power supply circuits as follows:

   1. Apply input power to power supply.

   2. With VTVM, measure DC voltage across capacitor A1C2. Measured DC voltage shall be 40 volts DC minimum.

3. With RMS voltmeter, measure AC ripple voltage across capacitor A1C2. Measured AC ripple voltage shall be no greater than 3.0 volts RMS.

c. Check +18-volt DC regulator circuits as follows:

1. Remove input power from power supply.

2. Connect a 20-ohm, 20-watt resistor between A1TP1 and A1TP2 (ground).

3. Apply input power to power supply.

4. With VTVM, measure DC voltage between pins A1TP1 and A1TP2 (ground). Measured DC voltage shall be between +17.9 and +19.7 volts DC.

5. With RMS voltmeter, measure AC ripple voltage between A1TP1 and A1TP2 (ground). Measured AC ripple voltage shall be no greater than 5 millivolts RMS.

d. Check +18-volt DC current limiting circuit as follows:

1. Remove input power from power supply.

2. Replace 20-ohm resistor between pins A1TP1 and A1TP2 with 25-ohm, 50-watt resistor.

3. Apply input power to power supply.

4. With VTVM, measure DC voltage between pins A1TP1 and A1TP2. Measured DC voltage shall be +25 ±1.3 volts DC.

5. Immediately after taking measurement in step 4, remove input power from power supply and disconnect resistor between A1TP1 and A1TP2.

e. Check -18-volt DC regulator circuits as follows:

1. Connect a 20-ohm, 20-watt resistor between pins A1TP3 and A1TP2 (ground).

2. Apply input power to power supply.

3. With VTVM, measure DC voltage between A1TP3 and A1TP2 (ground). Measured DC voltage shall be between -17.9 and -19.7 volts DC.

4. With RMS voltmeter, measure AC ripple voltage between A1TP3 and A1TP2 (ground). Measured AC ripple voltage shall be no greater than 5 millivolts RMS.

f. Check -18-volt DC current limiting circuit as follows:

1. Remove input power from power supply.

2. Replace 20-ohm resistor between A1TP3 and A1TP2 with a 25-ohm, 50-watt resistor.

3. Apply input power to power supply.

4. With VTVM, measure DC voltage between A1TP3 and A1TP2. Measured DC voltage shall be -25 ±1.3 volts DC.

5. Immediately after taking measurement in step 4, remove input power from power supply and disconnect resistor between A1TP3 and A1TP2.

4.3 Transistor Voltage Measurements

Table 2 provides typical DC voltages at transistor terminals on the power supply. All DC voltages are measured with respect to ground using a VTVM or a meter having a sensitivity of 20 kilohms per volt.

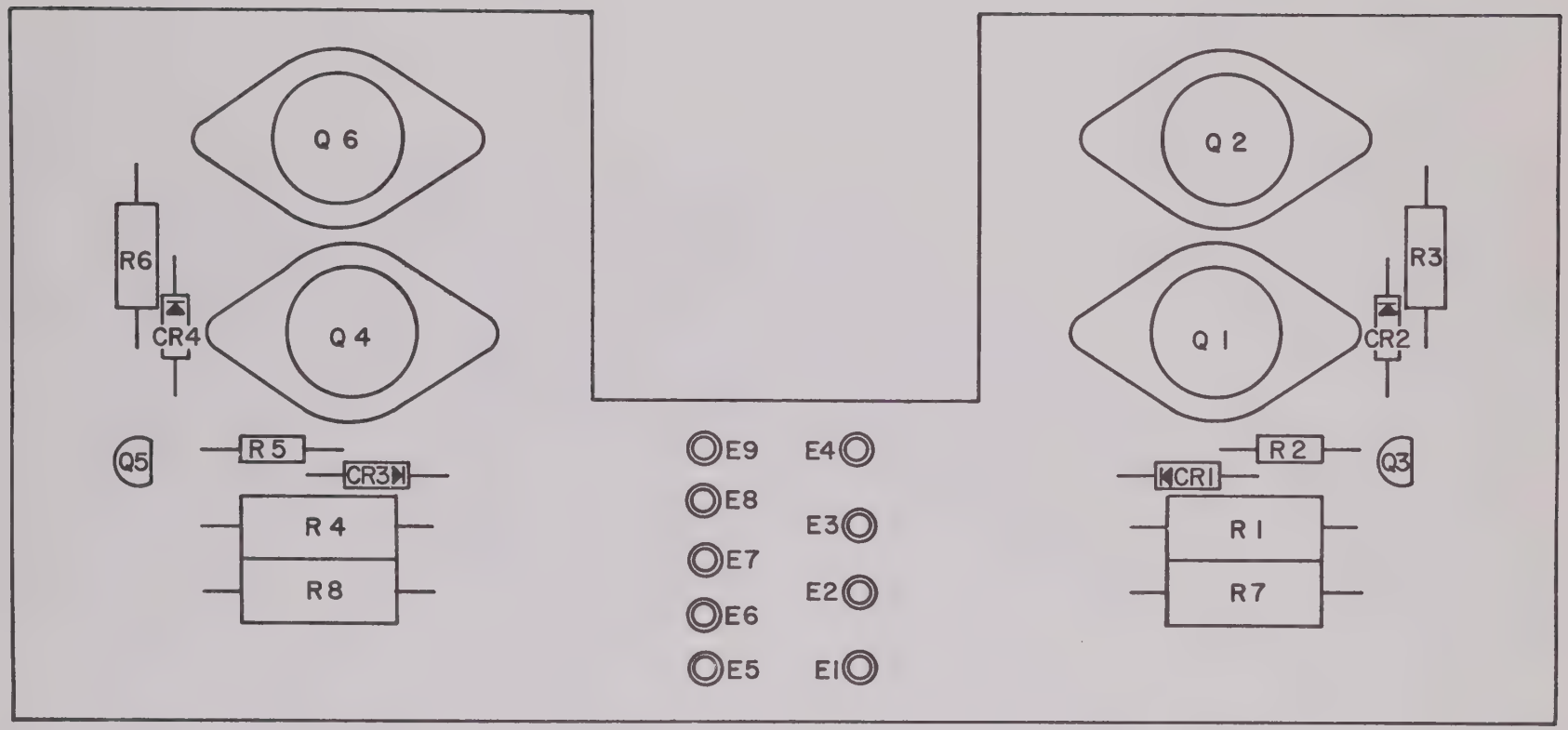
5. PARTS LIST

A tabular list of components contained in the EMR Model 4966 Power Supply is provided in Table 3. Chassis-mounted components, prefixed by assembly designation A1, are listed in the Ref. Desig., column are identified in Figure 1 and Table 1. Components on the voltage regulator card assembly A2 are identified in Figure 3. Each component listed in the Ref. Desig., column is described in the Description column. The component manufacturer and the manufacturer's part number are provided in the last two columns of the table.

Table 2. Power Supply, List of Transistor Voltages*

TRANSISTOR	BASE (V)	EMITTER (V)	COLLECTOR (V)
A2Q1	+35	+35	+20
A2Q2	+20	+19	+40
A2Q3	0	0.54	+20
Chassis Mounted A1Q1	+19	+18.5	+40
A2Q4	+16.5	+17	+2
A2Q5	-19	-19.5	+2
A2Q6	+2	+1	+21.5
Chassis Mounted A1Q2	+1	0	+21.5

* Voltages taken with regulated plus and minus 18-volt DC output loaded at 900 milliamperes.



EMR Drawing Control No. 4966-002

Figure 3. Component Location, Power Supply Voltage Regulator Card Assembly A2

Table 3. Parts List, EMR Model 4966 Power Supply

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
A1	MODEL 4966 POWER SUPPLY ASSEMBLY	EMR	7788
CR1 and CR2	RECTIFIER BRIDGE	Motorola	MDA952-2
C1 and C2	CAPACITOR**		
J1	CONNECTOR, Plug	Amphenol	126-220
P1	CONNECTOR, Receptacle (Mating connector for P1)	Amphenol	126-221
Q1 and Q2	TRANSISTOR	Motorola	2N3055
TP1	CONNECTOR, Test point (Red)	E.F. Johnson	105-252-1
TP2	CONNECTOR, Test point (Black)	E.F. Johnson	105-253-1
TP3	CONNECTOR, Test point (Violet)	E.F. Johnson	105-262-1
TP4 and TP5	CONNECTOR, Test point (Green)	E.F. Johnson	105-254-1
TP6	CONNECTOR, Test point (Orange)	E.F. Johnson	105-256-1
TP7	CONNECTOR, Test point (Brown)	E.F. Johnson	105-258-1
T1 and T2	TRANSFORMER, Power	Triad	F60-U
T3	TRANSFORMER, Power	EMR	6938
A2	VOLTAGE REGULATOR CARD ASSEMBLY	EMR	7790
CR1	DIODE	*	642
CR2	DIODE		1N4747A
CR3	DIODE	*	642
CR4	DIODE		1N4747A
Q1	TRANSISTOR		2N3740
Q2	TRANSISTOR		2N3054
Q3	TRANSISTOR		MPS6521
Q4	TRANSISTOR		2N3740
Q5	TRANSISTOR		MPS6521
Q6	TRANSISTOR		2N3054

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 4.

** C1 and C2 to be Sprague 36D262G050 AB6 2600 MFD 50V or CDE FAH252-502000 MFD 50V.

Table 3 (Cont'd.). Parts List, EMR Model 4966 Power Supply

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R1	RESISTOR, 2.2K ±10%, 1W	MIL-R-11/6	RC32GF222K
R2	RESISTOR, 3.6K ±5%, 1/4W	MIL-R-11/8	RC07GF362J
R3	RESISTOR, 1.8K ±10%, 1/2W	MIL-R-11/3	RC20GF182K
R4	RESISTOR, 2.2K ±10%, 1W	MIL-R-11/6	RC32GF222K
R5	RESISTOR, 3.6K ±5%, 1/4W	MIL-R-11/8	RC07GF362J
R6	RESISTOR, 1.8K ±10%, 1/2W	MIL-R-11/3	RC20GF182K
R7 and R8	RESISTOR, 0.6 ohm ±3%, 3W	*	621

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 4.

Table 4. Approved Vendors List

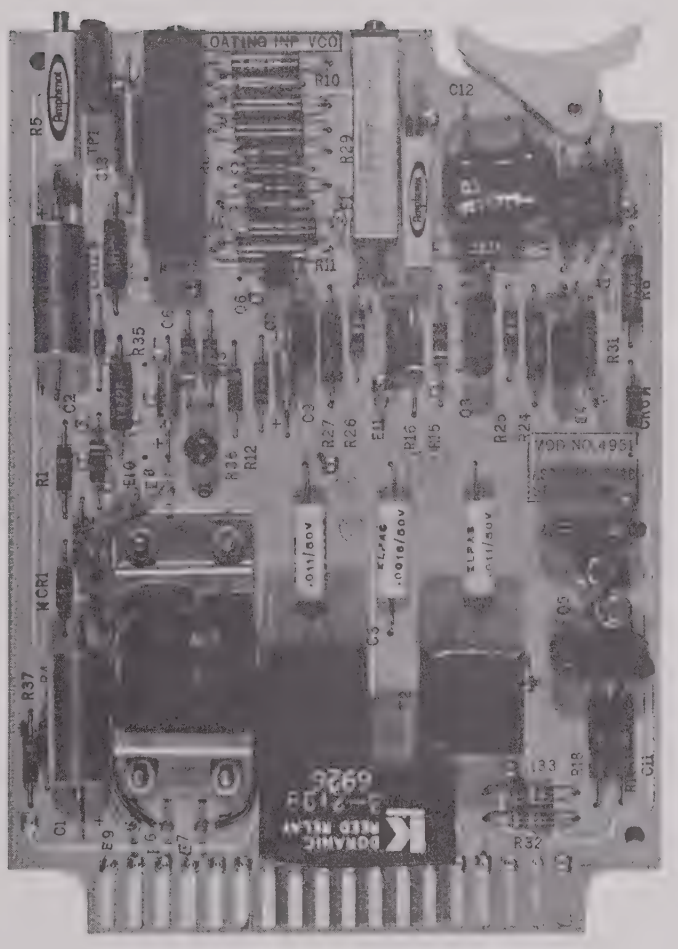
EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
600	Electro-Motive Mfg. Co.	DM Series
	Arco Electronics	DM Series
601	Kemet Company	J Series
	Sprague Electric Co.	CS13, 150D
	Mallory Capacitor Co.	TAS Series
	U.S. Semcor	TS-1 TS4
619	Alpha Wire Corp	
	Columbia Wire & Supply Co.	
621	Dale Electronics	RS-2C
	Sage Electronics	SA2W
	Ward-Leonard	3SX
	Mepco, Inc.	HT120
623	Dale Electronics	RS-5
	Ohmite	RW67
	Sage Electronics	1550S
624	IRC	EM
	Mepco	FE-10
	Dale	MF-1/10
	Sprague	416E
625	IRC	MEA
	Mepco	FE-12
	Dale Electronics	MF
	Ward-Leonard	WL60
	Electra	MF5
	Sprague	418E
639	Clevite Semiconductor	1N457
	Erie Tech. Prod.	1N457
	Fairchild Semiconductor	1N457
	Hughes Semiconductor	1N457
	Continental Device Corp.	1N457
	Raytheon	1N457
	Sylvania	1N457
	Transitron	1N457
	General Instrument	1N457
642	General Instrument	1N746A through 1N759A
	Hoffman	1N746A through 1N759A
	Motorola	1N746A through 1N759A
	Continental Device	1N746A through 1N759A
	Texas Instrument	1N746A through 1N759A
	Transitron	1N746A through 1N759A
	TRW	1N746A through 1N759A

Table 4 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
642	Western	1N746A through 1N759A
(Cont'd.)	International Rectifier	1N746A through 1N759A
	Hughes	1N746A through 1N759A
648	General Instrument	2N1309
	Texas Instrument	2N1309
	RCA	2N1309
649	General Instrument	2N404
	Texas Instrument	2N404
	RCA	2N404
658	Texas Instrument	2N2412
663	Transitron	SG-22
	Continental Device	CD1117
	Sylvania	DG472
666	General Electric	NPN
	General Instrument	NPN
	National Semiconductor	NPN
	Fairchild	NPN
	Motorola	NPN
671	General Electric	2N708
	General Instrument	2N708
	Texas Instrument	2N708
	RCA	2N708
	Motorola	2N708
	National Semiconductor	2N708
673	Continental Device	1N3064
	General Electric	1N3064
	Raytheon	1N3064
	Sylvania	1N3064
	Texas Instrument	1N3064
	Transitron	1N3064
694	Hughes	2N1131
	Motorola	2N1131
	Fairchild	2N1131
	Transitron	2N1131
	Texas Instrument	2N1131
800	Admiral Plastics	
	Delbert Blinn	
	Milton Ross	
	Thermalloy	
	Perfection Mica	
800-1	Milton Ross	
	Thermalloy	

Table 4 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
801	Motorola	2N2501
	General Instrument	2N2501
809	Electro-Motive Mfg. Co.	MPD Series
814	Fairchild	
	Western Semiconductors	
829	Texas Instrument	2N1308
	RCA	2N1308
834	Daystrom	
903	Fairchild	FA2411
905	Electro Cube, Inc.	
910	Continental Device	1N965
	Fairchild	1N965
	Motorola	SZ50548
919	Ledex, Inc.	
920	Ledex, Inc.	



EMR MODEL 4951

FLOATING INPUT VOLTAGE-CONTROLLED OSCILLATOR

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EMR MODEL 4951

FLOATING INPUT VOLTAGE-CONTROLLED OSCILLATOR

1. DESCRIPTION

The EMR Model 4951 Floating Input Voltage-Controlled Oscillator (VCO) is used in ground-based test installations to provide a subcarrier link between a data source and readout or recording devices. EMR Model 4951 Floating Input VCO's are available with subcarrier center-frequency outputs between 300 CPS and 200 Kc. The VCO subcarrier output can be deviated ±5% to ±15% with a sine-wave and ±16% to ±45% with a square-wave output. Input sensitivity is adjustable from 5 volts to 10 volts for full bandwidth modulation. An offset adjustment is provided to compensate for an offset of ±5 volts in the balanced input signal. Automatic switching of the VCO input allows calibration of the VCO by an external signal source.

All VCO components are mounted on a plug-in type printed-circuit card. An eighteen pin connector is printed on the card to provide all input and output connections. A card-mounted cam provides easy extraction of card from card guides.

Information pertaining to EMR Model 4951-01-M2 Floating Input VCO is contained in separate MSFN manual ME-2614.

2. SPECIFICATIONS

The following paragraphs contain electrical, physical, and environmental specifications for the Model 4951 Floating Input VCO.

2.1 Electrical Specifications:

a. Subcarrier Frequencies: Center frequencies from 300 CPS to 200 Kc.

b. Subcarrier Deviation: ±5% to ±15% with sine-wave output. ±16% to ±45% with square-wave output.

c. Input Voltage: Adjustable 5 volts to 10 volts for full bandwidth modulation.

d. Offset: Input voltage can be offset ±5 volts.

e. Input Impedance: The differential input impedance at a modulation frequency corresponding to a deviation ratio of 1 is as follows:

For IRIG channels 1-18, resistance is equal to or greater than 500K ohms in parallel with a capacitive reactance of not less than 500K ohms.

For IRIG channels A-E, resistance is equal to or greater than 250K ohms in parallel with a capacitive reactance of not less than 250K ohms. For units with deviations of ±16% to ±45%, resistance is equal to or greater than 100K ohms in parallel with a capacitive reactance of not less than 100K ohms.

f. Input Reverse Current: Differential input reverse current is equal to or less than 0.1 microampere DC for ±7.5% deviation units, equal to or less than 0.2 microampere DC for ±15% units, linearly increasing to 0.5 microamperes for ±45% units; less than 2.5 microamperes RMS AC.

g. Intelligence Response: Flat within 0.3 Db from DC to AC intelligence frequency corresponding to a modulation index of 5.

h. Common Mode Rejection: Equal to or greater than 100 Db at DC; equal to or greater than 80 Db at 60 CPS with balanced 600-ohm driving impedance. The common mode voltage may be as great as 50V peak.

i. Modulation Feedthru: Equal to or less than 0.5% of output voltage for all IRIG channels and equal to or less than 1.0% for channels with ±45% deviations, for modulation frequencies having a deviation ratio of 1 or greater.

j. Linearity: The best-straight-line linearity with full-scale deviation is equal to or less than ±0.1% of full bandwidth for ±7.5% deviation units, equal to or less than ±0.2% of full bandwidth for ±15% deviation units, and equal to or less than ±0.5% of full bandwidth for ±45% deviation units.

k. Subcarrier Output Impedance: An internal mixing resistor of 49.9K is provided. When used with the Model 4960 Mixing Amplifier, the subcarrier level from the mixing amplifier will be equal to or greater than 2.5 volts RMS. A linear taper of output-voltage versus channel frequency is available for pre-emphasis upon request.

l. Monitor Output: The monitor output impedance is equal to or less than 600 ohms and isolated from the subcarrier output.

m. Output Voltage:

Subcarrier and Monitor Output -- Adjustable up to 2.5V RMS open circuit.

The Model 4951 will not be damaged by the short circuit on either output.

n. Amplitude Modulation: The amplitude modulation of the output at full bandwidth deviation is equal to or less than ±5% for all IRIG channels.

o. Modulation Distortion: For IRIG channels 1-18, total harmonic distortion is equal to or less than 0.5% at a deviation ratio of 5 and equal to or less than 2.5% at a deviation ratio of 1 for full scale deviation. For IRIG channels A-E, total harmonic distortion is equal to or less than 1.0% at a deviation ratio of 5 and equal to or less than 5% at a deviation ratio of 1 for full scale deviation.

p. Subcarrier Distortion: Equal to or less than 1.0% RMS total distortion at any IRIG frequency.

q. Frequency Stability: At a constant temperature, the natural frequency will change equal to or less than 0.25% during an 8-hour period after a 15-minute warm-up. The natural frequency change is equal to or less than 80 PPM/°C over the temperature range of 0°C to 52°C.

r. Deviation Sensitivity Stability: The deviation sensitivity will change no more than ±1.0% of full bandwidth within an 8-hour period after a 15-minute warm-up when operated within the specified temperature range.

s. Power Requirements: +18.8V DC ±5% at 20 Ma, 12.6V AC at 20 Ma, and 18 to 40V DC at 12 Ma to operate calibration relay.

2.2 Physical Specifications

a. Length: 5-3/8 inches.

b. Width: 3-7/8 inches.

2.3 Environmental Specifications

The VCO shall operate at temperatures between 0°C and +52°C without degradation of performance. The VCO may be stored between temperatures of -65°C to +85°C.

3. INITIAL ADJUSTMENT

The initial adjustments to the EMR Model 4951 Floating Input VCO consists of setting the sensitivity, offset, and output amplitude controls. These controls are potentiometers located on the VCO printed-circuit card, and accessible from the top of the card.

The VCO may be set for various input voltage ranges from bandedge-to-bandedge deviation. Paragraph 3.1 lists the procedures for adjusting the VCO for an input voltage range of ±2.5 volts. Paragraph 3.2 lists the procedures for adjusting the VCO for an input voltage range of 0 to +10 volts. Paragraph 3.3 lists the procedures for adjusting the VCO for an input voltage range of 0 to -10 volts. The input voltages required for the following procedures may be obtained from a calibrator or an external DC voltage source applied to the input of the VCO. These procedures also require the use of a frequency meter and an RMS voltmeter.

3.1 ±2.5V Range

a. Ground input (pin 18) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain center frequency indication on frequency meter.

c. Remove ground from input (pin 18) and apply +2.5V to input.

d. Adjust R29 to obtain high-bandedge frequency indication on frequency meter.

e. Remove +2.5V from input (pin 18) and apply -2.5V to input.

f. Frequency meter shall indicate low-bandedge frequency.

g. Repeat above procedures as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

5

3.2 0 to +10V Range

a. Ground input (pin 18) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain low-bandedge frequency indication on frequency meter.

c. Remove ground from input (pin 18) and apply +10V to input.

d. Adjust R29 to obtain high-bandedge frequency indication on frequency meter.

e. Remove +10V from input (pin 18) and apply +5V to input.

f. Frequency meter shall indicate center frequency.

g. Repeat above procedure as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

3.3 0 to -10V Range

a. Ground input (pin 18) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain high-bandedge frequency indication on frequency meter.

c. Remove ground from input (pin 18) and apply -10V to input.

d. Adjust R29 to obtain low-bandedge frequency indication on frequency meter.

e. Remove -10V from input (pin 18) and apply -5V to input.

f. Frequency meter shall indicate center frequency.

g. Repeat above procedures as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

4. THEORY OF OPERATION

This paragraph provides a functional description of the EMR Model 4951 Floating Input VCO. The VCO theory of operation is discussed with reference to the block diagram, Figure 1 and schematic diagram, Figure 2.

The Model 4951 Floating Input VCO shown in Figure 1 is functionally divided into a floating 9-volt DC power supply, a voltage-controlled astable multivibrator circuit, a temperature compensation circuit, a VCO buffer, a band-pass filter, and an output buffer. The input-switching calibrate relay included as part of this assembly is shown in Figure 2.

4.1 Floating Power Supply Circuit

The floating power supply circuit, consisting of step-down transformer T1, full-wave rectifiers CR1 and CR2, capacitors C1 and C2, resistors R1 and R2, and zener diode CR3, provides a regulated +9-volts DC floating output to the astable multivibrator, temperature compensation circuit, and the VCO buffer amplifier circuits. The floating power supply enables the VCO to operate with a floating input by effectively isolating the VCO circuitry from ground. Zener diode CR3 regulates the power supply output at 9 ±0.45-volt DC.

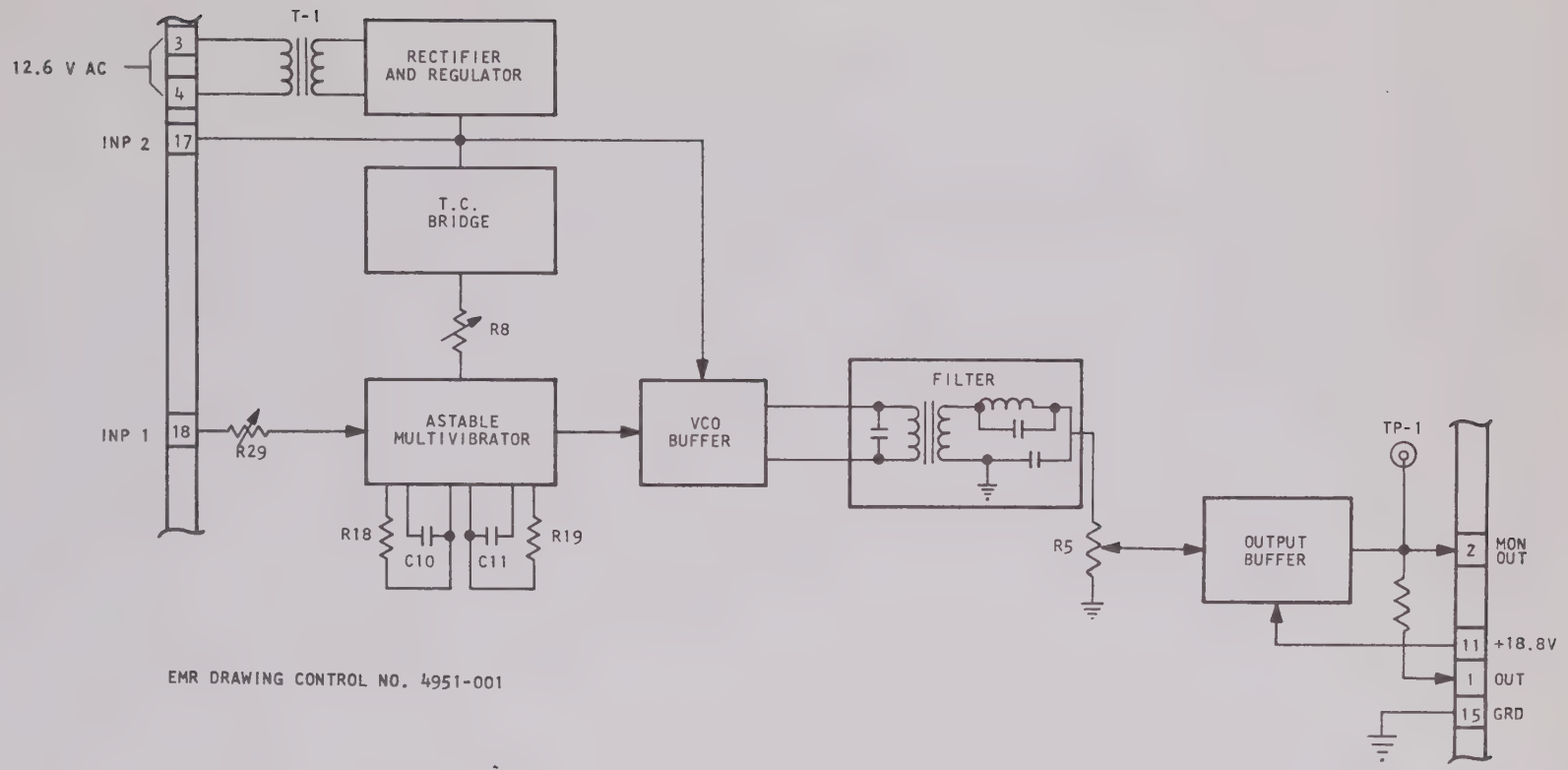


Figure 1. Block Diagram, Model 4951 Floating Input VCO

4.2 Astable Multivibrator Circuit

Astable (free-running) multivibrator (VCO) Q4-Q5, generates the VCO sub-carrier frequency output. The VCO center-frequency is adjusted by potentiometer R8. The output of the temperature-compensation bridge circuit is applied to the multivibrator circuit to correct for variations in center-frequency due to operating temperature fluctuations. The VCO center-frequency is deviated in proportion to the amplitude of the signal applied to the base of VCO transistors Q4 and Q5. The amplitude of the signal applied to Q4 and Q5 is adjusted by potentiometer R29. Relay K1 switches the input to the VCO from the normal floating input to a calibrate input referenced to ground. When relay K1 is energized by an external switch, input 2 is grounded at pin 13 and input 1 is connected to an external calibration signal applied at pin 6.

4.3 Temperature Compensation Circuit

Transistor Q6 and a temperature sensitive bridge circuit (consisting of diodes CR7 through CR11, resistors R10, R11, R22, R28, and R34, and potentiometer R21) comprise the temperature compensation circuit used to correct variations in VCO center frequency due to temperature fluctuations. At 25°C, R21 is factory adjusted to provide a zero-volt input to transistor Q6. Transistor Q6 is connected in parallel with VCO transistors Q4 and Q5. As conduction of Q6 varies, the emitter and effective collector load resistances for Q4 and Q5 change and the VCO frequency shifts proportionately. When the VCO operating temperature fluctuates above or below 25°C, the forward resistance of silicon diodes CR8 through CR11 changes and current flows through R21 in the bridge circuit. The voltages appearing at the wiper of R21 changes the conduction of Q6 and produces a corresponding change in center frequency. Diode CR12 provides additional VCO temperature compensation to maintain the VCO bandwidth characteristics at higher VCO frequencies.

4.4 VCO Buffer

Complementary amplifiers Q2 and Q3 buffer the VCO square-wave output applied to transformer T2 in the output filter. The high input impedance of transistor Q2 and Q3 isolates the VCO multivibrator from the loading effects of transformer T2. Transistors Q2 and Q3 function as a switch by conducting on alternate half-cycles of the VCO square-wave output.

4.5 Band-Pass Filter and Output Buffer

Filter FL1 passes the VCO fundamental frequency and attenuates the undesired harmonic frequencies. The filter consists of push-pull transformer T2, inductor L1, capacitors C3 through C5 and resistors R35. The square-wave outputs from buffer amplifiers Q2 and Q3 are applied to the center-tapped primary of transformer T2. The symmetrical square-wave output appearing across the secondary of transformer T2 is referenced to ground at card pin 15. The filter output produces a sine-wave output for VCO frequency deviations from

±5% to ±15% and a square-wave output for VCO frequency deviations from ±16% to ±45%.

The filtered VCO output is applied through level potentiometer R5 to the input of output buffer Q1. Output buffer is an emitter-follower which provides a low impedance VCO frequency output to output pin 1 and monitor output pin 2. Potentiometer R5 adjusts the VCO subcarrier frequency output level between 0 and 3.0-volts RMS. Test point TP1, is accessible from the top edge of the card and is provided for monitoring the VCO output. The output buffer is protected against accidental grounding by capacitor C7.

5. MAINTENANCE

This paragraph contains information to aid in troubleshooting and maintenance of the Model 4951 Floating Input VCO. The information is used in conjunction with the theory of operation in Paragraph 4, so that maintenance may be performed with maximum efficiency.

In the event a malfunction occurs, the following general method of troubleshooting and repairing is recommended.

a. Perform visual inspection (Paragraph 5.1).

b. Extend VCO from mounting drawer using card extender and troubleshoot by checking transistor voltages (refer to Paragraph 5.2), with reference to the schematic diagram shown in Figure 2, and component location diagram shown in Figure 3.

c. After the defective component is located, refer to the parts list (Paragraph 6), for a component description.

d. Once the repair has been accomplished, perform initial adjustment procedures (Paragraph 3.)

5.1 Inspection

The Model 4951 Floating Input VCO should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following inspection should be performed periodically as a means of preventive maintenance or, if a malfunction occurs, to aid in isolating the trouble.

a. Inspect VCO for mechanical damage and for component discoloration caused by overheating.

b. Inspect mating connector in mounting drawer for signs of damage or potential trouble spots.

5.2 Transistor Voltage Measurements

A tabular listing of typical transistor voltages for the VCO is provided in Table 1.

Table 1. VCO Typical Transistor Voltages

	E	B	C
Q1	N.A.	N.A	N.A
Q2	0	+0.44	+6.0
Q3	0	+0.44	+6.0
Q4	+0.18	+0.04	+5.6
Q5	+0.18	+0.04	+5.6
Q6	+5.2	+4.60	0

6. PARTS LIST

The Model 4951 Floating Input VCO parts list is provided in Tables 2, 3, and 4. Parts information is presented in tabular form and is keyed to the circuit symbols of components on the component location diagram, Figure 3.

The parts list (Table 2) is divided into the following columns: Ref. Desig., providing the reference designation of the component; Description, providing a complete description of the item; Manufacturer, providing the name and manufacturer's part number where applicable. For some components, the Manufacturers column contains an EMR source control number. These components are identified by an asterisk in the name portion of the column. In the Part No. column, a coded number references an approved vendor for that item in Table 5, Approved Vendors List.

Table 2 also references Table 3 for variable components. In this table a complete EMR part number code is listed for parts where applicable. The following examples are explanations of how to determine the part value and characteristics from the code number.

600-1282075

600 - Basic part number, refer to Table 5.
82 - Indicates capacitance significant digits.
0 - Indicates number of zeros to be added after significant digits to list value in Pf.

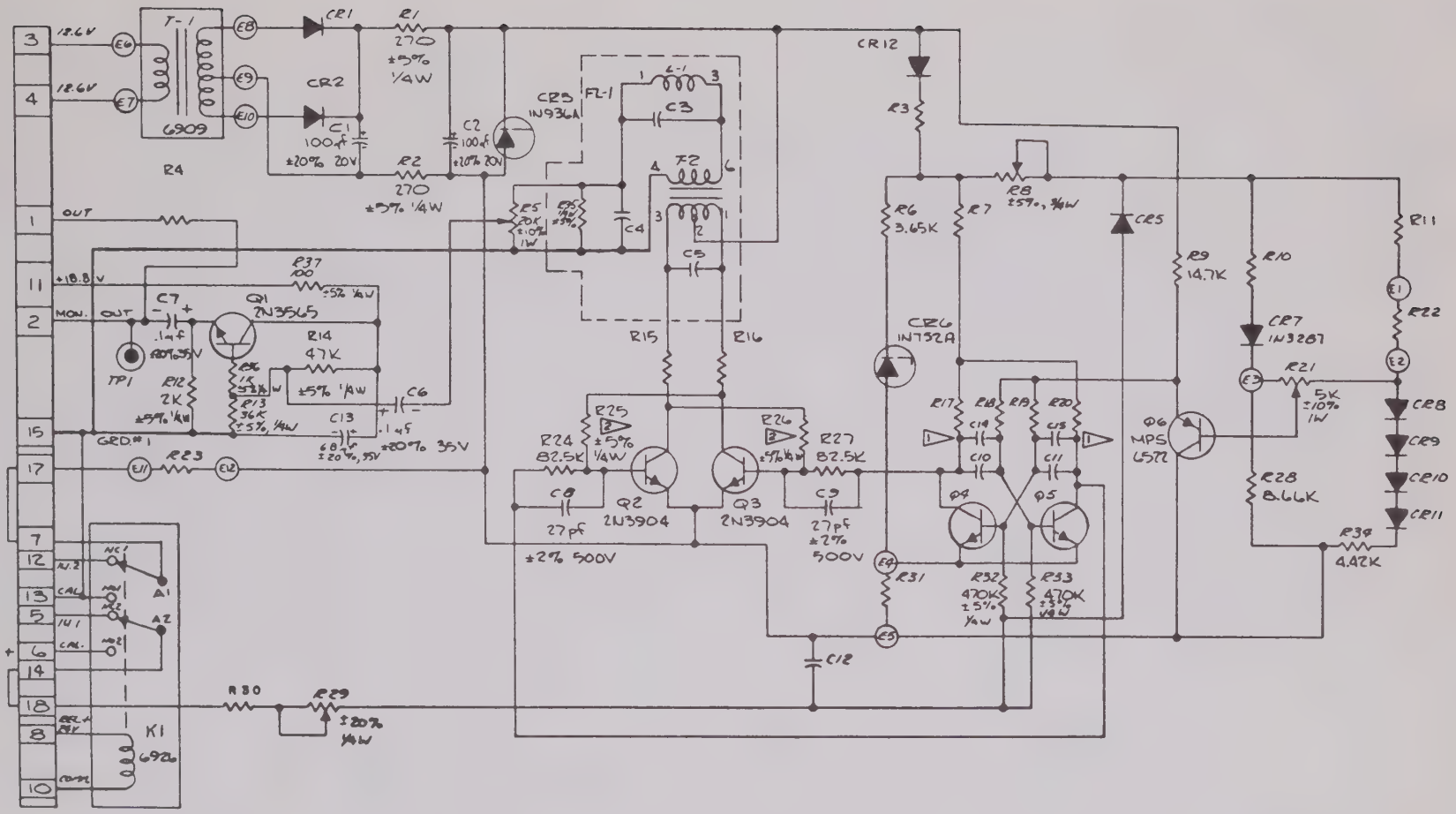
625-100411

625 - Basic part number, refer to Table 5.
100 - Significant digits.
4 - Indicates number of zeros to be added after significant digits to list value in ohms.

809-6802111

809 - Basic part number, refer to Table 5.
680 - Capacitance significant digits.
2 - Indicates number of zeros to be added after significant digits to list value in Pf.

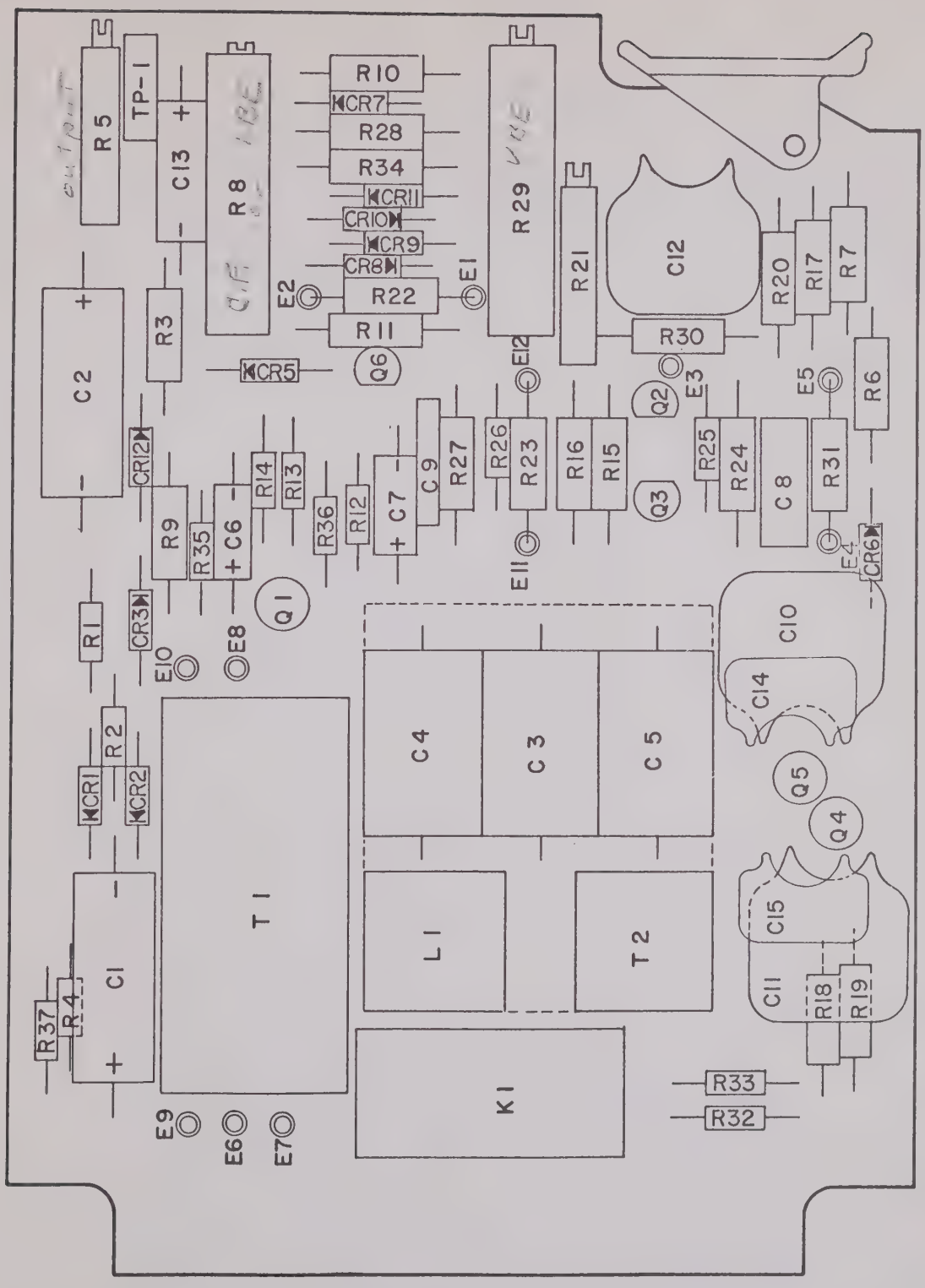
For components in VCO filter FL1, reference is made to Table 4. In Table 4, all component values and types are listed for units operating at standard IRIG frequencies.



NOTES:

1. VALUES TO BE DETERMINED IN TEST. USED ONLY ON 0.4 KC UNITS.
2. VALUES TO BE DETERMINED IN TEST.
3. REFER TO PARTS LIST FOR COMPONENT VALUES NOT SHOWN.
4. EMR DRAWING NO. 6898.

Figure 2. Schematic Diagram, Model 4951 Floating Input VCO



EMR DRAWING CONTROL NO. 4951-002

Figure 3. Component Location Diagram, Model 4951 Floating Input VCO

Table 2. Parts List, Model 4951 Floating Input VCO

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
	MODEL 4951 FLOATING INPUT VCO ASSEMBLY	EMR	6896
CR1	DIODE	*	814
CR2	DIODE	*	814
CR3	DIODE		1N936A
CR5	DIODE, See Table 3		
CR6	DIODE, 1N752A	*	642
CR7	DIODE		1N3287
CR8	DIODE	*	814
CR9	DIODE	*	814
CR10	DIODE	*	814
CR11	DIODE	*	814
CR12	DIODE, See Table 3		
C1	CAPACITOR, 100 µf ±20%, 20V	*	601
C2	CAPACITOR, 100 µf ±20%, 20V	*	601
C3	CAPACITOR, Part of Filter FL1, See Table 4		
C4	CAPACITOR, Part of Filter FL1, See Table 4		
C5	CAPACITOR, Part of Filter FL1, See Table 4		
C6	CAPACITOR, 0.1 µf ±20%, 35V	*	601
C7	CAPACITOR, 0.1 µf ±20%, 35V	*	601
C8	CAPACITOR, 27 Pf ±2%, 500V	*	600
C9	CAPACITOR, 27 Pf ±2%, 500V	*	600
C10	CAPACITOR, See Table 3		
C11	CAPACITOR, See Table 3		
C12	CAPACITOR, See Table 3		
C13	CAPACITOR, 6.8 µf ±20%, 35V	*	601
C14	CAPACITOR, Test variable, Type DM15		
C15	CAPACITOR, Test variable, Type DM15		
Q1	TRANSISTOR		2N3565
Q2	TRANSISTOR		2N3904
Q3	TRANSISTOR		2N3904
Q4	TRANSISTOR, See Table 3		
Q5	TRANSISTOR, See Table 3		
Q6	TRANSISTOR	Motorola	MPS6522
R1	RESISTOR, 270Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 271J
R2	RESISTOR, 270Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 271J

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 5.

Table 2 (Cont'd.). Parts List, Model 4951 Floating Input VCO

REF. DESIG.	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART NO.
R3	RESISTOR, See Table 3, ±1%, 1/8W		
R4	RESISTOR, Test variable, ±5%, 1/4W	MIL-R-11/8	RC07GF XXXJ
R5	RESISTOR, 20K ±10%, 1W	Amphenol	2600P 203
R6	RESISTOR, 3.65K ±1%, 1/8W	*	625
R7	RESISTOR, See Table 3, ±1%, 1/8W		
R8	RESISTOR, See Table 3, ±5%, 3/4W	Clarostat	76JA-3
R9	RESISTOR, 14.7K ±1%, 1/8W	*	625
R10	RESISTOR, See Table 3, ±1%, 1/8W		
R11	RESISTOR, See Table 3, ±1%, 1/8W		
R12	RESISTOR, 2K ±5%, 1/4W	MIL-R-11/8	RC07GF 202J
R13	RESISTOR, 36K ±5%, 1/4W	MIL-R-11/8	RC07GF 363J
R14	RESISTOR, 47K ±5%, 1/4W	MIL-R-11/8	RC07GF 473J
R15	RESISTOR, See Table 3		
R16	RESISTOR, See Table 3		
R17	RESISTOR, See Table 3		
R18	RESISTOR, See Table 3		
R19	RESISTOR, See Table 3		
R20	RESISTOR, See Table 3		
R21	RESISTOR, 5K ±10%, 1W	Amphenol	2600P-502
R22	RESISTOR, Test variable, ±1%, 1/8W	*	625
R23	RESISTOR, Test variable, ±1%, 1/8W	*	625
R24	RESISTOR, 82.5K ±1%, 1/8W	*	625
R25	RESISTOR, Test variable, ±5%, 1/4W	MIL-R-11/8	RC07GF XXXJ
R26	RESISTOR, Test variable, ±5%, 1/4W	MIL-R-11/8	RC07GF XXXJ
R27	RESISTOR, 82.5K ±1%, 1/8W	*	625
R28	RESISTOR, 8.66K ±1%, 1/8W	*	625
R29	RESISTOR, See Table 3, ±20%, 1/4W	Bourns	276P
R30	RESISTOR, See Table 3		
R31	RESISTOR, Test variable, ±1%, 1/3W	*	625
R32	RESISTOR, 470K ±5%, 1/4W	MIL-R-11/8	RC07GF 474J
R33	RESISTOR, 470K ±5%, 1/4W	MIL-R-11/8	RC07GF 474J

*Coded number in Part No. column identifies approved manufacturer and part number located in Table 5.

Table 2 (Cont'd.). Parts List, Model 4951 Floating Input VCO

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R34	RESISTOR, 4.42K ±1%, 1/8W	*	625
R35	RESISTOR, Part of Filter FL1, See Table 4		
R36	RESISTOR, 1K ±5%, 1/4W	MIL-R-11/8	RC07GF 102J
R37	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
FL1	FILTER	EMR	6946
K1	RELAY	EMR	6926
L1	COIL, Part of Filter FL1, See Table 4		
T1	TRANSFORMER	EMR	6909
T2	TRANSFORMER, Part of Filter FL1, See Table 4		

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 5.

Table 3. Variable Component List

FREQUENCY KC	DEV %	*C10 & *C11 PF	C12	R7	R-11	R-10	R-8 Ω [2]	R-29 KΩ [2]	R-30
.400	7.5	KA1062FK50G	809-2002111	625-732131	625-182131	625-182131	2000	1000	625-287331
.560	7.5	7640	809-1502111	625-732131	↑	↑	↑	↑	↑
.730	7.5	5850	809-1502111	625-732131					
.960	7.5	4420	809-1002111	625-715131					
1.30	7.5	3270	600-3468243	625-715131					
1.70	7.5	2500	600-3456243	625-715131					
2.30	7.5	1845 [1/]	600-3447245	625-715131					
3.00	7.5	1400	600-3433245	625-698131					
3.90	7.5	1070	600-3422245	625-698131					
5.40	7.5	771	600-3415245	625-681131 [2/]					
7.35	7.5	560	600-3415245	625-663131					
10.5	7.5	390	600-2482143	625-634131					
14.5	7.5	272	600-2468143	625-562131 [3/]					
22.0	7.5	171	600-2447145	625-499131					
30.0	7.5	120	600-2433145	625-402131					
40.0	7.5	86	600-2422145	625-280131					
52.5	7.5	62	600-2415145	625-133131					
70.0	7.5	43	600-2410145	625-301031	625-182131	625-182131	2000	1000	625-287331
22.0	15.0	171	600-2447145	625-499131	625-237031	625-261031	5000	750	↑
30.0	15.0	120	600-2433145	625-442131 [4/]	↑	↑	↑	↑	
40.0	15.0	86	600-2422145	625-402231					NOTE 2
52.5	15.0	62	600-2415145	625-162131					
70.0	15.0	43	600-2410145	625-301031	625-237031	625-261031	5000	750	↓
100.0	7.5	39	600-2368045	625-340131	625-182131	625-182131	2000	1000	625-287331

EMR DRAWING NO. 6943

NOTES:

1. *C10 AND *C11 ARE DM15 UP TO 1000 PF, DM19 UP TO 8200 PF AND ARE ±1% 300V. KA-TYPES UP TO 30,000 PF, ±2% 50V.
2. R30 IS A FIXED COMPOSITION RESISTOR, 240K OHMS ±5%, 1/4W MIL. SPEC MIL-R-11/8 PART NO. RC07GF244J

[2] R8 IS A CLAROSTAT POTENTIOMETER, TYPE 76JA-3.
R29 IS A BOURNS POTENTIOMETER, TYPE 276P.

1/ FOR SOME UNITS, AN 1800 PF CAPACITOR IS USED.

2/ FOR SOME UNITS, AN EMR 625-698131 RESISTOR IS USED.

3/ FOR SOME UNITS, AN EMR 625-590131 RESISTOR IS USED.

4/ FOR SOME UNITS, AN EMR 625-402131 RESISTOR IS USED.

Table 4. Component Values and Types, EMR 6946 Filter, FL1

CHANNEL NO'S	CENTER FREQUENCY IN KHZ, & DEV. IN%	C3 PF	C4 PF	C5 PF	L1	T2	R35 OHMS
1	0.400±7.5%	10,000	62,000	68,000	6944-001	6945-001	NOT USED
2	0.560±7.5%	7,500	43,000	47,000	-002	-002	
3	0.730±7.5%	5,600	33,000	36,000	-003	-003	
4	0.960±7.5%	4,300	24,000	27,000	-004	-004	
5	1.300±7.5%	3,300	18,000	20,000	-005	-005	
6	1.700±7.5%	2,400	15,000	16,000	-006	-006	
7	2.300±7.5%	1,800	11,000	11,000	-007	-007	
8	3.000±7.5%	1,300	8,200	8,200	-008	-008	
9	3.900±7.5%	1,100	6,200	6,200	-009	-009	
10	5.400±7.5%	750	4,700	4,300	-010	-010	
11	7.350±7.5%	560	3,300	3,000	-011	-011	
12	10.50±7.5%	430	2,400	2,200	-012	-012	
13	14.50±7.5%	300	1,800	1,600	-013	-013	
14	22.00±7.5%	200	1,100	1,000	-014	-014	
15	30.00±7.5%	130	820	750	-015	-015	
16	40.00±7.5%	110	620	500	-016	-016	
17	52.50±7.5%	82	470	390	-017	-017	
18	70.00±7.5%	62	360	270	-018	-018	
A	22.00±15.0%	130	750	820	-019	-019	
B	30.00±15.0%	100	560	560	-020	-020	
C	40.00±15.0%	75	430	390	-021	-021	
D	52.50±15.0%	51	330	270	-022	-022	
E	70.00±15.0%	36	250	180	6944-023	6945-023	NOT USED
REF.	100.00±7.5%	33	250	180	6944-024	6945-024	NOT USED

NOTES:

1. THE FILTER, FL1, PART NUMBER IS CODED AS FOLLOWS:

   6946-XXXX-XXX
   - XXX — PERCENT OF DEVIATION
   - XXXX — CENTER FREQUENCY IN KHZ

2. CAPACITOR TYPES ARE AS FOLLOWS:

   A. 0 TO 1000 PF - ARCO TYPE DM-15
   ±2%, 100V (OR GREATER)

   B. 1001 TO 68,000 PF - ELPAC TYPE
   PDA, ±2%, 50V (OR GREATER)

3. COIL L1 IS AN EMR TYPE 6944-0XX

4. TRANSFORMER T1 IS AN EMR TYPE 6945-0XX

5. EMR DRAWING NO. 6946

Table 5. Approved Vendors List

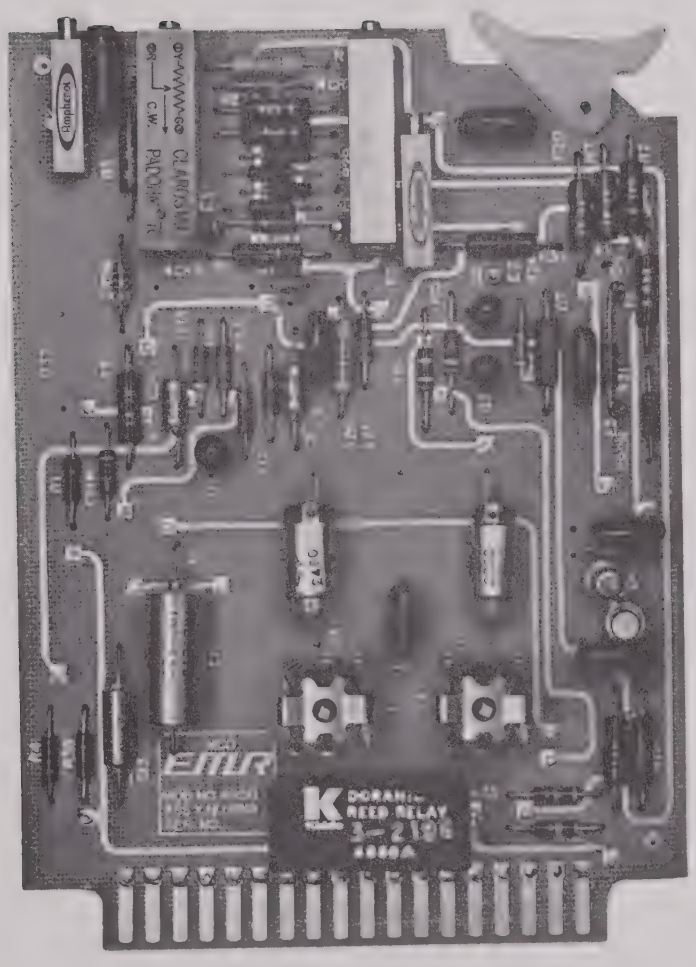
EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
600	Electro-Motive Mfg. Co.	DM Series
	Arco Electronics	DM Series
601	Kemet Company	J Series
	Sprague Electric Co.	CS13, 150D
	Mallory Capacitor Co.	TAS Series
	U.S. Semcor	TS-1 TS4
619	Alpha Wire Corp	
	Columbia Wire & Supply Co.	
621	Dale Electronics	RS-2C
	Sage Electronics	SA2W
	Ward-Leonard	3SX
	Mepco, Inc.	HT120
623	Dale Electronics	RS-5
	Ohmite	RW67
	Sage Electronics	1550S
624	IRC	EM
	Mepco	FE-10
	Dale	MF-1/10
	Sprague	416E
625	IRC	MEA
	Mepco	FE-12
	Dale Electronics	MF
	Ward-Leonard	WL60
	Electra	MF5
	Sprague	418E
639	Clevite Semiconductor	1N457
	Erie Tech. Prod.	1N457
	Fairchild Semiconductor	1N457
	Hughes Semiconductor	1N457
	Continental Device Corp.	1N457
	Raytheon	1N457
	Sylvania	1N457
	Transitron	1N457
	General Instrument	1N457
642	General Instrument	1N746A through 1N759A
	Hoffman	1N746A through 1N759A
	Motorola	1N746A through 1N759A
	Continental Device	1N746A through 1N759A
	Texas Instrument	1N746A through 1N759A
	Transitron	1N746A through 1N759A
	TRW	1N746A through 1N759A

Table 5 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
642 (Cont'd.)	Western	1N746A through 1N759A
	International Rectifier	1N746A through 1N759A
	Hughes	1N746A through 1N759A
648	General Instrument	2N1309
	Texas Instrument	2N1309
	RCA	2N1309
649	General Instrument	2N404
	Texas Instrument	2N404
	RCA	2N404
658	Texas Instrument	2N2412
663	Transitron	SG-22
	Continental Device	CD1117
	Sylvania	DG472
666	General Electric	NPN
	General Instrument	NPN
	National Semiconductor	NPN
	Fairchild	NPN
	Motorola	NPN
671	General Electric	2N708
	General Instrument	2N708
	Texas Instrument	2N708
	RCA	2N708
	Motorola	2N708
	National Semiconductor	2N708
673	Continental Device	1N3064
	General Electric	1N3064
	Raytheon	1N3064
	Sylvania	1N3064
	Texas Instrument	1N3064
	Transitron	1N3064
694	Hughes	2N1131
	Motorola	2N1131
	Fairchild	2N1131
	Transitron	2N1131
	Texas Instrument	2N1131
800	Admiral Plastics	
	Delbert Blinn	
	Milton Ross	
	Thermalloy	
	Perfection Mica	
800-1	Milton Ross	
	Thermalloy	

Table 5 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
801	Motorola	2N2501
	General Instrument	2N2501
809	Electro-Motive Mfg. Co.	MPD Series
814	Fairchild	
	Western Semiconductors	
829	Texas Instrument	2N1308
	RCA	2N1308
834	Daystrom	
903	Fairchild	FA2411
905	Electro Cube, Inc.	
910	Continental Device	1N965
	Fairchild	1N965
	Motorola	SZ50548
919	Ledex, Inc.	
920	Ledex, Inc.	



EMR MODEL 4950

REFERENCE VOLTAGE-CONTROLLED OSCILLATOR

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EMR MODEL 4950

REFERENCE VOLTAGE-CONTROLLED OSCILLATOR

1. DESCRIPTION

The EMR Model 4950 Reference Voltage-Controlled Oscillator (VCO) is used to provide the reference signal in systems using tape-speed compensation (TSC). The output signal is mixed with the data subcarrier signals as part of the multiplex. EMR Model 4950 Reference VCO's are available with center-frequency outputs between 300 CPS and 200 Kc. The VCO output can be deviated ±5% to ±15% with a sine-wave and ±16% to ±45% with a square-wave output. Input sensitivity is adjustable from 5 volts to 10 volts for full bandwidth modulation. An offset adjustment is provided to compensate for an offset of ±5 volts in the balanced input signal. Automatic switching of the VCO input allows calibration of the VCO by an external signal source.

All VCO components are mounted on a plug-in type printed-circuit card. An eighteen pin connector is printed on the card to provide all input and output connections. A card-mounted cam provides easy extraction of card from card guides.

2. SPECIFICATIONS

The following paragraphs contain electrical, physical, and environmental specifications for the Model 4950 Reference VCO.

2.1 Electrical Specifications:

a. Subcarrier Frequencies: Center frequencies from 300 CPS to 200 Kc.

b. Subcarrier Deviation: ±5% to ±15% with sine-wave output. ±16% to ±45% with square-wave output.

c. Input Voltage: Adjustable 5 volts to 10 volts for full bandwidth modulation.

d. Offset: Input voltage can be offset ±5 volts.

e. Input Impedance: The differential input impedance at a modulation frequency corresponding to a deviation ratio of 1 is as follows:

For IRIG channels 1-18, resistance is equal to or greater than 500K ohms in parallel with a capacitive reactance of not less than 500K ohms.

For IRIG channels A-E, resistance is equal to or greater than 250K ohms in parallel with a capacitive reactance of not less than 250K ohms. For units with deviations of ±16% to ±45%, resistance is equal to or greater than 100K ohms in parallel with a capacitive reactance of not less than 100K ohms.

f. Input Reverse Current: Input reverse current is equal to or less than 0.1 microampere DC for ±7.5% deviation units and equal to or less than 0.2 microampere DC for ±15% units, linearly increasing to 0.5 microampere for ±45% units; less than 2.5 microamperes RMS AC.

g. Intelligence Response: Flat within 0.3 Db from DC to AC intelligence frequency corresponding to a modulation index of 5.

h. Modulation Feedthru: Equal to or less than 0.5% of output voltage for all IRIG channels and equal to or less than 1.0% for channels up to ±45% deviation for modulation frequencies having a deviation ratio of 1 or greater.

i. Linearity: The best-straight-line linearity with full-scale deviation is equal to or less than ±0.1% of full bandwidth for ±7.5% deviation units, and equal to or less than ±0.2% of full bandwidth for ±15% deviation units, and 0.5% of full bandwidth for ±45% deviation units.

j. Subcarrier Output Impedance: An internal mixing resistor of 49.9K is provided. When used with the Model 4960 Mixing Amplifier, the subcarrier level from the mixing amplifier will be equal to or greater than 2.5 volts RMS. A linear taper of output voltage versus channel frequency is available for pre-emphasis upon request.

k. Monitor Output: The monitor output impedance is equal to or less than 600 ohms and isolated from the subcarrier output.

l. Output Voltage:

Subcarrier and Monitor Output -- Adjustable up to 2.5V RMS open circuit.

The Model 4950 will not be damaged by the short circuit on either output.

m. Amplitude Modulation: The amplitude modulation of the output at full bandwidth deviation is equal to or less than ±5% for all IRIG channels.

n. Modulation Distortion: For IRIG channels 1-18, total harmonic distortion is equal to or less than 0.5% at a deviation ratio of 5 and equal to or less than 2.5% at a deviation ratio of 1 for full scale deviation. For IRIG channels A-E, total harmonic distortion is equal to or less than 1.0% at a deviation ratio of 5 and equal to or less than 5% at a deviation ratio of 1 for full scale deviation.

o. Subcarrier Distortion: Equal to or less than 1.0% RMS total distortion at any IRIG frequency.

p. Frequency Stability: At a constant temperature, the natural frequency will change equal to or less than 0.25% during an 8-hour period after a 15-minute warm-up. The natural frequency change is equal to or less than 80 PPM/°C over the temperature range of 0°C to 52°C.

q. Deviation Sensitivity Stability: The deviation sensitivity will change no more than ±1.0% of full bandwidth within an 8-hour period after a 15-minute warm-up when operated within the specified temperature range.

r. Power Requirements: +18.8V DC ±5% at 20 Ma, and 18 to 40V DC at 12 Ma to operate calibration relay.

2.2 Physical Specifications

a. Length: 5-3/8 inches.

b. Width: 3-7/8 inches.

2.3 Environmental Specifications

The VCO shall operate at temperatures between 0°C and +52°C without degradation of performance. The VCO may be stored between temperatures -65°C to +85°C.

3. INITIAL ADJUSTMENT

The initial adjustments to the EMR Model 4950 Reference VCO consists of setting the sensitivity, offset, and output amplitude controls. These controls are potentiometers located on the VCO printed-circuit card, and accessible from the top of the card.

The VCO may be set for various input voltage ranges for bandedge-to-bandedge deviation. Paragraph 3.1 lists the procedures for adjusting the VCO for an input voltage range of ±2.5 volts. Paragraph 3.2 lists the procedures for adjusting the VCO for an input voltage range of 0 to +10 volts. Paragraph 3.3 lists the procedures for adjusting the VCO for an input voltage range of 0 to -10 volts. The input voltages required for the following procedures may be obtained from a calibrator or an external DC voltage source applied to the input of the VCO. These procedures also require the use of a frequency meter and a RMS voltmeter.

3.1 ±2.5V Range

a. Ground input (pin 5) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain center frequency indication on frequency meter.

c. Remove ground from input (pin 5) and apply +2.5V to input.

d. Adjust R29 to obtain high-bandedge frequency indication on frequency meter.

e. Remove +2.5V from input (pin 5) and apply -2.5V to input.

f. Frequency meter shall indicate low-bandedge frequency.

g. Repeat above procedures as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

3.2 0 to +10V Range

a. Ground input (pin 5) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain low-bandedge frequency indication on frequency meter.

c. Remove ground from input (pin 5) and apply +10V to input.

d. Adjust R29 to obtain high-bandedge frequency indication on frequency meter.

e. Remove +10V from input (pin 5) and apply +5V to input.

f. Frequency meter shall indicate center frequency.

g. Repeat above procedure as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

3.3 0 to -10V Range

a. Ground input (pin 5) to VCO. Connect frequency meter to TP1.

b. Adjust R8 to obtain high-bandedge frequency indication on frequency meter.

c. Remove ground from input (pin 5) and apply -10V to input.

d. Adjust R29 to obtain low-bandedge frequency indication on frequency meter.

e. Remove -10V from input (pin 5) and apply -5V to input.

f. Frequency meter shall indicate center frequency.

g. Repeat above procedures as necessary to eliminate interaction between controls.

h. Disconnect frequency meter from TP1 and connect RMS voltmeter to TP1.

i. Adjust R5 to obtain desired output amplitude as indicated on RMS voltmeter.

4. THEORY OF OPERATION

This paragraph provides a functional description of the EMR Model 4950 Reference VCO. The VCO theory of operation is discussed with reference to the block diagram, Figure 1 and schematic diagram, Figure 2.

The Model 4950 Reference VCO shown in Figure 1, is functionally divided into a floating 9-volt DC power supply, a voltage-controlled astable multivibrator circuit, a temperature compensation circuit, a VCO buffer, a bandpass filter, and an output buffer. The input-switching calibrate relay included as part of this assembly is shown in Figure 2.

4.1 Regulated +9-Volt DC Regulator

Regulated +9-volt DC power to VCO astable multivibrator, temperature compensation circuit, and the VCO buffer amplifier circuits is provided by resistor R1, zener diode CR1 and capacitor C1. The negative side of the regulator is referenced to ground at card pin 15.

4.2 Astable Multivibrator Circuit

Astable (free-running) multivibrator (VCO) Q4-Q5 generates the VCO subcarrier frequency output. The VCO center frequency is adjusted by potentiometer R8. The output of the temperature compensation bridge circuit is applied to the multivibrator circuit to correct variations in center-frequency due to temperature fluctuations. Since the reference VCO is not

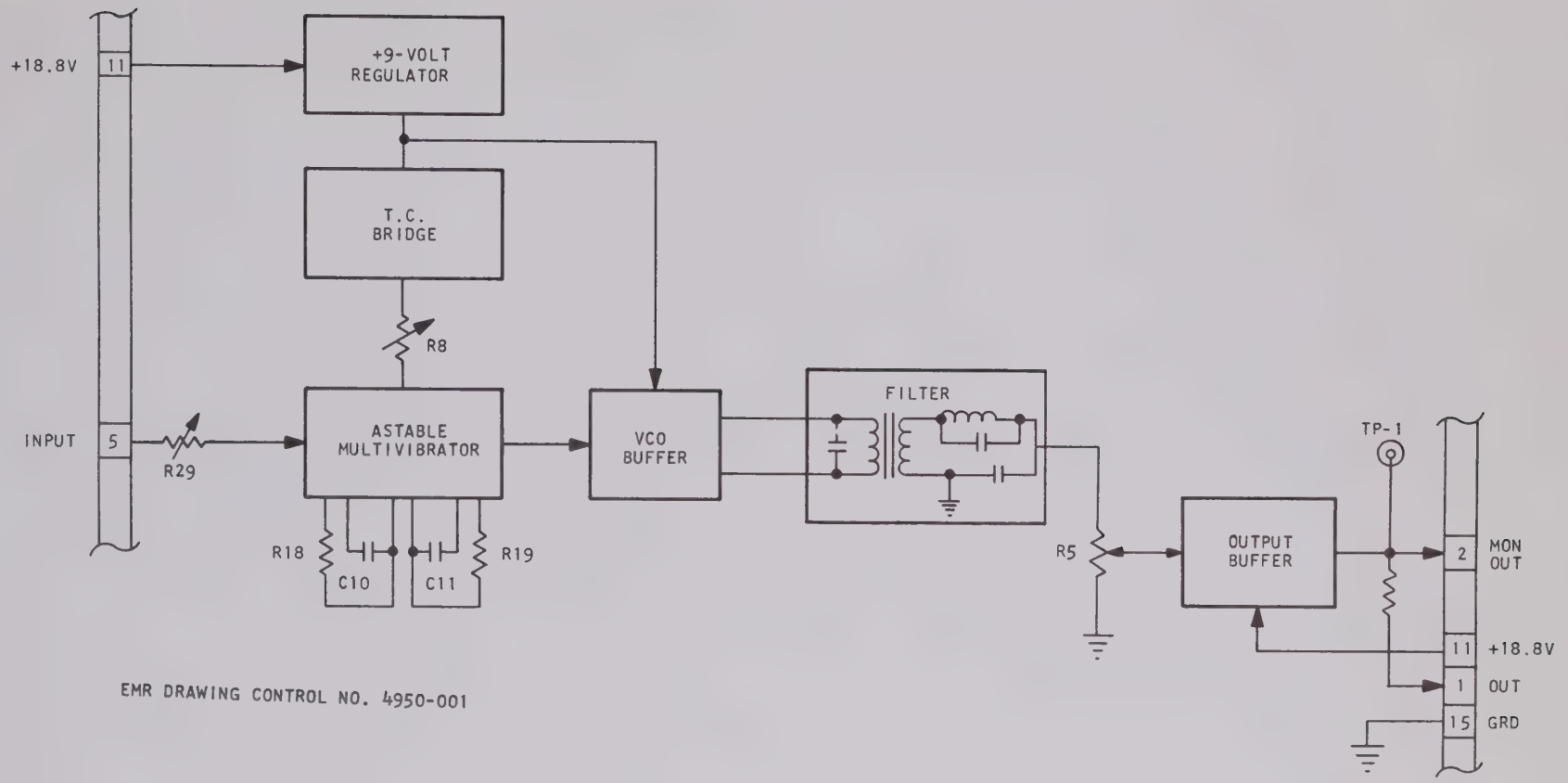


Figure 1. Block Diagram, Model 4950 Reference VCO

deviated during normal operation, the signal input to the VCO is grounded at card pin 5 when calibrate relay K1 is deenergized. When relay K1 is energized by an external switch, a calibrate input at card pin 6 may be applied to the multivibrator to check VCO operation.

4.3 Temperature Compensation Circuit

Transistor Q6 and a temperature sensitive bridge (consisting of diodes CR3, CR4, CR6, CR7, and CR8, resistors R10, R11, R22, R27, and R28, and potentiometer R21) comprise the temperature compensation circuit to correct variations in VCO center frequency due to temperature fluctuations. At 25°C, R21 is factory adjusted to provide a zero-volt input to transistor Q6. Transistor Q6 is connected in parallel with VCO transistors Q4 and Q5. As conduction of Q6 varies, the emitter and effective collector load resistances for Q4 and Q5 change and the VCO frequency shifts proportionately. When the VCO operating temperature fluctuates above or below 25°C, the forward resistance of silicon diodes CR4 through CR8 changes and current flows through R21 in the bridge circuit. The voltages appearing at the wiper of R21 changes the conduction of Q6 and produces a corresponding change in center frequency. Diode CR9 provides additional VCO temperature compensation to maintain the VCO bandwidth characteristics at high VCO frequencies.

4.4 VCO Buffer

Complementary amplifiers Q2 and Q3 buffer the VCO square-wave output applied to transformer T2 in the output filter. The high input impedance of transistor Q2 and Q3 isolates the VCO multivibrator from the loading effects of transformer T2. Transistors Q2 and Q3 function as a switch by conducting on alternate half-cycles of the VCO square-wave output.

4.5 Band-Pass Filter and Output Buffer

Filter FL1 passes the VCO fundamental frequency and attenuates the undesired harmonic frequencies. The filter consists of push-pull transformer T2, inductor L1, capacitors C3 through C5 and resistor R35. The square-wave outputs from buffer amplifiers Q2 and Q3 are applied to the center-tapped primary of transformer T2. The symmetrical square-wave output appearing across the secondary of transformer T2 is referenced to ground at card pin 15. The filter output is a sine wave.

The filtered VCO output is applied through level potentiometer R5 to the input of output buffer Q1. Output buffer is an emitter-follower which provides a low impedance VCO frequency output to output pin 1 and monitor output pin 2. Potentiometer R5 adjusts the VCO subcarrier frequency output level between 0 and 3.0-volts RMS. Test point TP1, is accessible from the top edge of the card and is provided for monitoring the VCO output. The output buffer is protected against accidental grounding by capacitor C7.

5. MAINTENANCE

This paragraph contains information to aid in troubleshooting and maintenance of the Model 4950 Reference VCO. The information is used in conjunction with the theory of operation in Paragraph 4, so that maintenance may be performed with maximum efficiency.

In the event a malfunction occurs, the following general method of troubleshooting and repairing is recommended.

a. Perform visual inspection (Paragraph 5.1).

b. Extend VCO from mounting drawer using card extender and troubleshoot by checking transistor voltages (refer to Paragraph 5.2), with reference to the schematic diagram shown in Figure 2, and component location diagram shown in Figure 3.

c. After the defective component is located, refer to the parts list (Paragraph 6), for a component description.

d. Once the repair has been accomplished, perform initial adjustment procedures (Paragraph 3).

5.1 Inspection

The Model 4950 Reference VCO should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following inspection should be performed periodically as a means of preventive maintenance or, if a malfunction occurs, to aid in isolating the trouble.

a. Inspect VCO for mechanical damage and for component discoloration caused by overheating.

b. Inspect mating connector in mounting drawer for signs of damage or potential trouble spots.

5.2 Transistor Voltage Measurements

A tabular listing of typical transistor voltages for the VCO is provided in Table 1.

Table 1. VCO Typical Transistor Voltages

Transistor	E	B	C
Q1	N.A.	N.A.	N.A.
Q2	0	+0.44	+6.0
Q3	0	+0.44	+6.0
Q4	+0.18	+0.04	+5.6
Q5	+0.18	+0.04	+5.6
Q6	+5.2	+4.60	0

6. PARTS LIST

The Model 4950 Reference VCO parts list is provided in Tables 2, 3, and 4. Parts information is presented in tabular form and is keyed to the circuit symbols of components on the component location diagram, Figure 3.

The parts list (Table 2) is divided into the following columns: Ref. Desig., providing the reference designation of the component; Description, providing a complete description of the item; Manufacturer, providing the name and manufacturer's part number where applicable. For some components, the Manufacturers column contains an EMR source control number. These components are identified by an asterisk in the name portion of the column. In the Part No. column, a coded number references an approved vendor for that item in Table 5, Approved Vendors List.

Table 2 also references Table 3 for variable components. In this table a complete EMR part number code is listed for parts where applicable. The following examples are explanations of how to determine the part value from the code number.

600-1282075

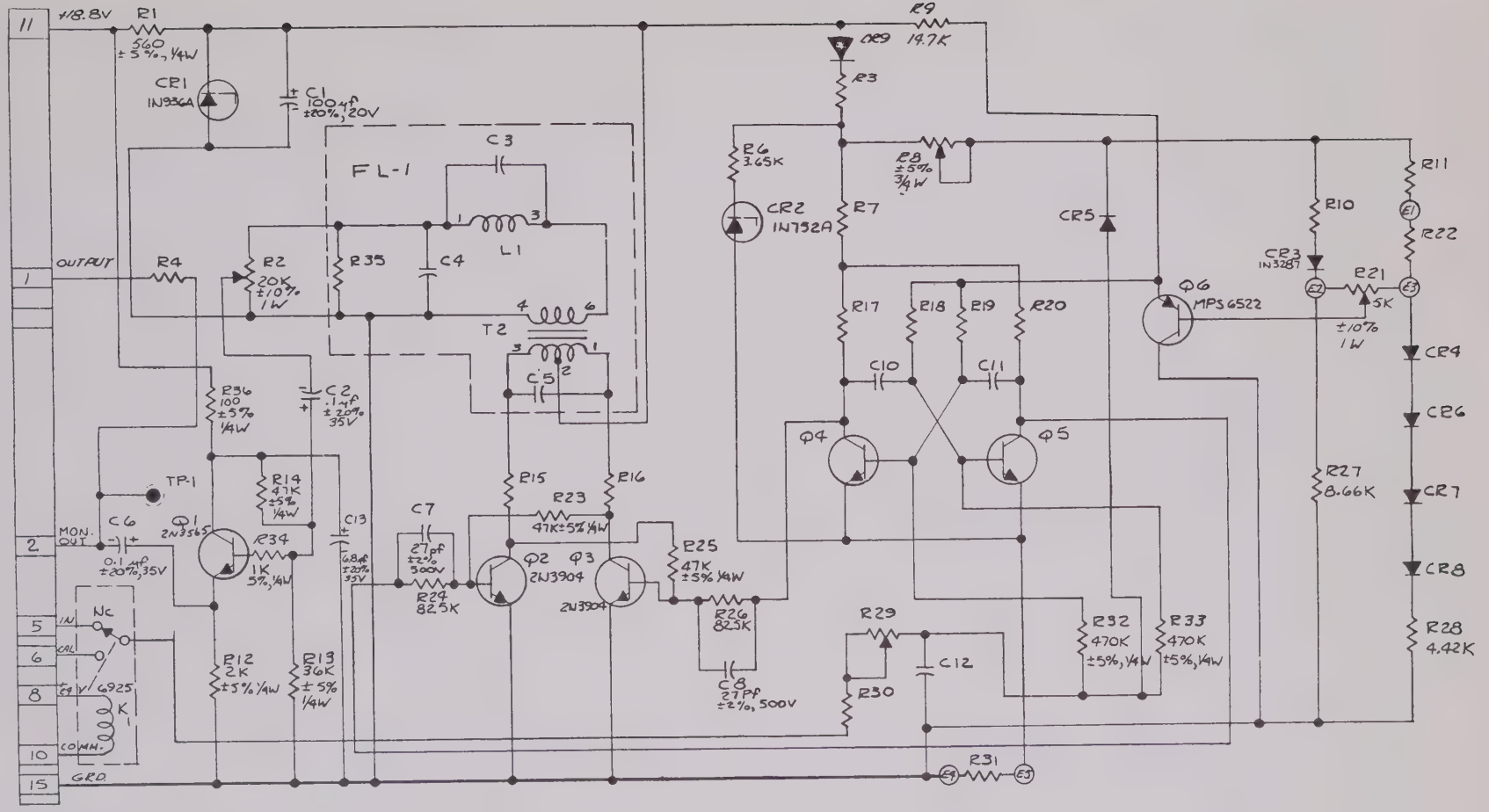
600 - Basic part number, refer to Table 5.
82 - Indicates capacitance significant digits.
0 - Indicates number of zeros to be added after significant digits to list value in Pf.

625-100411

625 - Basic part number, refer to Table 5.
100 - Significant digits.
4 - Indicates number of zeros to be added after significant digits to list value in ohms.

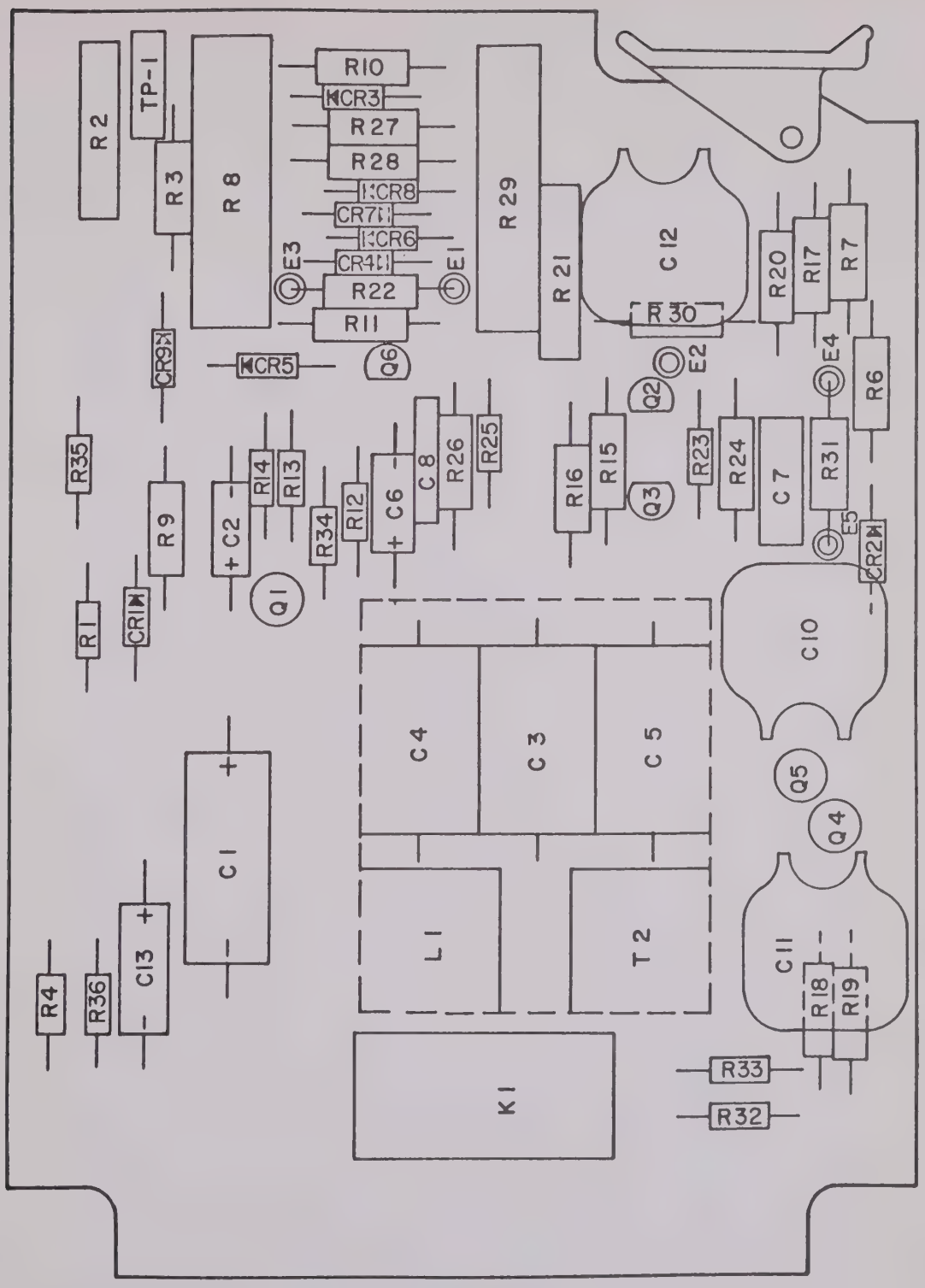
809 - Basic part number, refer to Table 5.
680 - Capacitance significant digits.
2 - Indicates number of zeros to be added after significant digits to list value in Pf.

For components in VCO filter FL1, reference is made to Table 4. In Table 4, all component values and types are listed for units operating at standard IRIG frequencies.



NOTES:
1. REFER TO PARTS LIST FOR COMPONENT VALUES NOT SHOWN.
2. EMR DRAWING NO. 6920.

Figure 2. Schematic Diagram, Model 4950 Reference VCO



EMR DRAWING CONTROL NO. 4950-002

Figure 3. Component Location Diagram, Model 4950 Reference VCO

Table 2. Parts List, Model 4950 Reference Oscillator

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
	MODEL 4950 REFERENCE OSCILLATOR ASSEMBLY	EMR	6918
CR1	DIODE		1N936A
CR2	DIODE, 1N752A	*	642
CR3	DIODE		1N3287
CR4	DIODE	*	814
CR5	DIODE, See Table 3		
CR6	DIODE	*	814
CR7	DIODE	*	814
CR8	DIODE	*	814
CR9	DIODE, See Table 3		
C1	CAPACITOR, 100 µf ±20%, 20V	*	601
C2	CAPACITOR, 0.1 µf ±20%, 35V	*	601
C3	CAPACITOR, Part of Filter FL1, See Table 4		
C4	CAPACITOR, Part of Filter FL1, See Table 4		
C5	CAPACITOR, Part of Filter FL1, See Table 4		
C6	CAPACITOR, 0.1 µf ±20%, 35V	*	601
C7	CAPACITOR, 27 Pf ±2%, 500V	*	600
C8	CAPACITOR, 27 Pf ±2%, 500V	*	600
C10	CAPACITOR, See Table 3		
C11	CAPACITOR, See Table 3		
C12	CAPACITOR, See Table 3		
C13	CAPACITOR, 6.8 µf ±20%, 35V	*	601
R1	RESISTOR, 560Ω ±5%, 1/4W	MIL-R-11/8	RC07GF561J
R2	RESISTOR, 20K ±10%, 1W	Amphenol	2600P-203
R3	RESISTOR, See Table 3, ±1%, 1/8W		
R4	RESISTOR, Test variable, ±5%, 1/4W	MIL-R-11/8	RC07GFXXXJ
R6	RESISTOR, 3.65K ±1%, 1/8W	*	625
R7	RESISTOR, See Table 3, ±1%, 1/8W		
R8	RESISTOR, See Table 3, ±5%, 3/4W	Clarostat	76JA-3
R9	RESISTOR, 14.7K ±1%, 1/8W	*	625
R10	RESISTOR, See Table 3, ±1%, 1/8W		
R11	RESISTOR, See Table 3, ±1%, 1/8W		
R12	RESISTOR, 2K ±5%, 1/4W	MIL-R-11/8	RC07GF202J

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 5.

Table 2 (Cont'd.). Parts List, Model 4950 Reference Oscillator

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R13	RESISTOR, 36K ±5%, 1/4W	MIL-R-11/8	RC07GF363J
R14	RESISTOR, 47K ±5%, 1/4W	MIL-R-11/8	RC07GF473J
R15	RESISTOR, See Table 3, ±1%, 1/8W		
R16	RESISTOR, See Table 3, ±1%, 1/8W		
R17	RESISTOR, See Table 3, ±1%, 1/8W		
R18	RESISTOR, See Table 3, ±1%, 1/8W		
R19	RESISTOR, See Table 3, ±1%, 1/8W		
R20	RESISTOR, See Table 3, ±1%, 1/8W		
R21	RESISTOR, 5K ±10%, 1W	Amphenol	2600P-502
R22	RESISTOR, Test variable, ±1%, 1/8W	*	625
R23	RESISTOR, 47K ±5%, 1/4W	MIL-R-11/8	RC07GF473J
R24	RESISTOR, 82.5K ±1%, 1/8W	*	625
R25	RESISTOR, 47K ±5%, 1/4W	MIL-R-11/8	RC07GF473J
R26	RESISTOR, 82.5K ±1%, 1/8W	*	625
R27	RESISTOR, 8.66K ±1%, 1/8W	*	625
R28	RESISTOR, 4.42K ±1%, 1/8W	*	625
R29	RESISTOR, See Table 3, ±20%, 1/4W	Bourns	276P
R30	RESISTOR, See Table 3, ±1%, 1/8W		
R31	RESISTOR, Test variable, ±1%, 1/8W	*	625
R32	RESISTOR, 470K ±5%, 1/4W	MIL-R-11/8	RC07GF474J
R33	RESISTOR, 470K ±5%, 1/4W	MIL-R-11/8	RC07GF474J
R34	RESISTOR, 1K ±5%, 1/4W	MIL-R-11/8	RC07GF102J
R35	RESISTOR, Part of Filter FL1, See Table 4		
R36	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF101J
Q1	TRANSISTOR		2N3565
Q2	TRANSISTOR		2N3904
Q3	TRANSISTOR		2N3904
Q4	TRANSISTOR, See Table 3		
Q5	TRANSISTOR, See Table 3		
Q6	TRANSISTOR	Motorola	MPS6522

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 5.

Table 2 (Cont'd.). Parts List, Model 4950 Reference Oscillator

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
FL1	FILTER	EMR	6946-XXXX-XXX
K1	RELAY	EMR	6925
L1	COIL, Part of Filter FL1, See Table 4		
T2	TRANSFORMER, Part of Filter FL1, See Table 4		

Table 3. Variable Component List

FREQUENCY KC	DEV %	*C10 &*C11 PF	C12	R7	R30	R-11	R-10	[2] R-8 Ω	[2] R-29 KΩ
.400	7.5	KA1062FK50G	809-2002111	625-732131	625-287331	625-182131	625-182131	2000	1000
.560	7.5	7640	809-1502111	625-732131	↑	↑	↑	↑	↑
.730	7.5	5850	809-1502111	625-732131					
.960	7.5	4420	809-1002111	625-715131					
1.30	7.5	3270	600-3468243	625-715131					
1.70	7.5	2500	600-3456243	625-715131,					
2.30	7.5	1845 1/	600-3447245	625-715131					
3.00	7.5	1400	600-3433245	625-698131					
3.90	7.5	1070	600-3422245	625-698131					
5.40	7.5	771	600-3415245	625-681131 2/					
7.35	7.5	560	600-3415245	625-665131					
10.5	7.5	390	600-2482143	625-634131					
14.5	7.5	272	600-2468143	625-562131 3/					
22.0	7.5	171	600-2447145	625-499131					
30.0	7.5	120	600-2433145	625-402131					
40.0	7.5	86	600-2422145	625-280131					
52.5	7.5	62	600-2415145	625-133131	↓	↓	↓	↓	↓
70.0	7.5	43	600-2410145	625-301031	625-287331	625-182131	625-182131	2000	1000
22.0	15.0	171	600-2447145	625-499131	625-422131	625-237031	625-261031	5000	750
30.0	15.0	120	600-2433145	625-442131 4/	↑	↑	↑	↑	↑
40.0	15.0	86	600-2422145	625-402231					
52.5	15.0	62	600-2415145	625-162131					
70.0	15.0	43	600-2410145	625-301031	625-422131	625-237031	625-261031	5000	750
100.0	7.5	39	600-2368045	625-340131	625-287331	625-182131	625-182131	2000	1000

NOTES:

1. *C10 AND *C11 ARE DM15 UP TO 1000 PF, DM19 UP TO 8200 PF AND ARE ±1% 300V. KA-TYPES UP TO 30,000 PF, ±2% 50V.

[2] R8 IS A CLAROSTAT POTENTIOMETER, TYPE 76JA-3.
R29 IS A BOURNS POTENTIOMETER, TYPE 276P.

1/ FOR SOME UNITS, AN 1800 PF CAPACITOR IS USED.

2/ FOR SOME UNITS, AN EMR 625-698131 RESISTOR IS USED.

3/ FOR SOME UNITS, AN EMR 625-590131 RESISTOR IS USED.

4/ FOR SOME UNITS, AN EMR 625-402131 RESISTOR IS USED.

EMR DRAWING NO. 6943

Table 3 (Cont'd.). Variable Component List

CR-5	Q4 & Q5	R-17 & 20	R-18 & 19	R-15 & 16	R-3	CR9 (4950)	CR12 (4951)
NA	2N3947	625-182231	625-215331	RC07GF392J	625-681031	1N4829	1N4829
NA	2N3947						
EMR 814	EMR 900						
					625-681031	1N4829	1M4829
					625-215031	1N3287	1N3287
EMR 814	EMR 900	625-182231	625-215331	RC07GF392J	625-215031	1N3287	1N3287
EMR 814	EMR 900	625-121231	625-215321	RC07GF392J	625-681031	1N4829	1N4829

Table 4. Component Values and Types, EMR 6946 Filter, FL1

CHANNEL NO'S	CENTER FREQUENCY IN KHZ, & DEV. IN %	C3 PF	C4 PF	C5 PF	L1	T2	R35 OHMS
1	0.400±7.5%	10,000	62,000	68,000	6944-001	6945-001	NOT USED
2	0.560±7.5%	7,500	43,000	47,000	-002	-002	
3	0.730±7.5%	5,600	33,000	36,000	-003	-003	
4	0.960±7.5%	4,300	24,000	27,000	-004	-004	
5	1.300±7.5%	3,300	18,000	20,000	-005	-005	
6	1.700±7.5%	2,400	15,000	16,000	-006	-006	
7	2.300±7.5%	1,800	11,000	11,000	-007	-007	
8	3.000±7.5%	1,300	8,200	8,200	-008	-008	
9	3.900±7.5%	1,100	6,200	6,200	-009	-009	
10	5.400±7.5%	750	4,700	4,300	-010	-010	
11	7.350±7.5%	560	3,300	3,000	-011	-011	
12	10.50±7.5%	430	2,400	2,200	-012	-012	
13	14.50±7.5%	300	1,800	1,600	-013	-013	
14	22.00±7.5%	200	1,100	1,000	-014	-014	
15	30.00±7.5%	130	820	750	-015	-015	
16	40.00±7.5%	110	620	500	-016	-016	
17	52.50±7.5%	82	470	390	-017	-017	
18	70.00±7.5%	62	360	270	-018	-018	
A	22.00±15.0%	130	750	820	-019	-019	
B	30.00±15.0%	100	560	560	-020	-020	
C	40.00±15.0%	75	430	390	-021	-021	
D	52.50±15.0%	51	330	270	-022	-022	
E	70.00±15.0%	36	250	180	6944-023	6945-023	NOT USED
REF.	100.00±7.5%	33	250	180	6944-024	6945-024	NOT USED

NOTES:

1. THE FILTER, FL1, PART NUMBER IS CODED AS FOLLOWS:

   6946-XXXX-XXX
   - XXX — PERCENT OF DEVIATION
   - XXXX — CENTER FREQUENCY IN KHZ

2. CAPACITOR TYPES ARE AS FOLLOWS:

   A. 0 TO 1000 PF - ARCO TYPE DM-15
   ±2%, 100V (OR GREATER)

   B. 1001 TO 68,000 PF - ELPAC TYPE
   PDA, ±2%, 50V (OR GREATER)

3. COIL L1 IS AN EMR TYPE 6944-0XX

4. TRANSFORMER T1 IS AN EMR TYPE 6945-0XX

5. EMR DRAWING NO. 6946

Table 5. Approved Vendors List

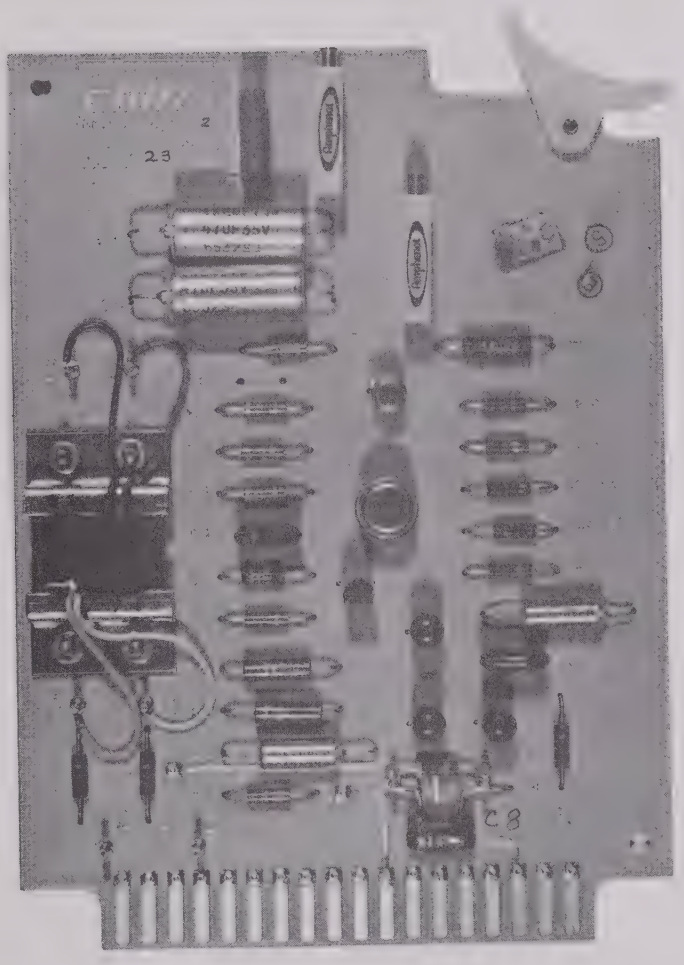
EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
600	Electro-Motive Mfg. Co.	DM Series
	Arco Electronics	DM Series
601	Kemet Company	J Series
	Sprague Electric Co.	CS13, 150D
	Mallory Capacitor Co.	TAS Series
	U.S. Semcor	TS-1 TS4
619	Alpha Wire Corp	
	Columbia Wire & Supply Co.	
621	Dale Electronics	RS-2C
	Sage Electronics	SA2W
	Ward-Leonard	3SX
	Mepco, Inc.	HT120
623	Dale Electronics	RS-5
	Ohmite	RW67
	Sage Electronics	1550S
624	IRC	EM
	Mepco	FE-10
	Dale	MF-1/10
	Sprague	416E
625	IRC	MEA
	Mepco	FE-12
	Dale Electronics	MF
	Ward-Leonard	WL60
	Electra	MF5
	Sprague	418E
639	Clevite Semiconductor	1N457
	Erie Tech. Prod.	1N457
	Fairchild Semiconductor	1N457
	Hughes Semiconductor	1N457
	Continental Device Corp.	1N457
	Raytheon	1N457
	Sylvania	1N457
	Transitron	1N457
	General Instrument	1N457
642	General Instrument	1N746A through 1N759A
	Hoffman	1N746A through 1N759A
	Motorola	1N746A through 1N759A
	Continental Device	1N746A through 1N759A
	Texas Instrument	1N746A through 1N759A
	Transitron	1N746A through 1N759A
	TRW	1N746A through 1N759A

Table 5 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
642 (Cont'd.)	Western	1N746A through 1N759A
	International Rectifier	1N746A through 1N759A
	Hughes	1N746A through 1N759A
648	General Instrument	2N1309
	Texas Instrument	2N1309
	RCA	2N1309
649	General Instrument	2N404
	Texas Instrument	2N404
	RCA	2N404
658	Texas Instrument	2N2412
663	Transitron	SG-22
	Continental Device	CD1117
	Sylvania	DG472
666	General Electric	NPN
	General Instrument	NPN
	National Semiconductor	NPN
	Fairchild	NPN
	Motorola	NPN
671	General Electric	2N708
	General Instrument	2N708
	Texas Instrument	2N708
	RCA	2N708
	Motorola	2N708
	National Semiconductor	2N708
673	Continental Device	1N3064
	General Electric	1N3064
	Raytheon	1N3064
	Sylvania	1N3064
	Texas Instrument	1N3064
	Transitron	1N3064
694	Hughes	2N1131
	Motorola	2N1131
	Fairchild	2N1131
	Transitron	2N1131
	Texas Instrument	2N1131
800	Admiral Plastics	
	Delbert Blinn	
	Milton Ross	
	Thermalloy	
	Perfection Mica	
800-1	Milton Ross	
	Thermalloy	

Table 5 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
801	Motorola	2N2501
	General Instrument	2N2501
809	Electro-Motive Mfg. Co.	MPD Series
814	Fairchild	
	Western Semiconductors	
829	Texas Instrument	2N1308
	RCA	2N1308
834	Daystrom	
903	Fairchild	FA2411
905	Electro Cube, Inc.	
910	Continental Device	1N965
	Fairchild	1N965
	Motorola	SZ50548
919	Ledex, Inc.	
920	Ledex, Inc.	



EMR MODEL 4960

MIXING AMPLIFIER

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EMR MODEL 4960

MIXING AMPLIFIER

1. DESCRIPTION

The EMR Model 4960 Mixing Amplifier linearly multiplexes the outputs of ground-based voltage-controlled oscillators (VCO's) and amplifies the composite signal for driving, recording, or demultiplexing instruments in FM telemetry systems. As many as 30 VCO outputs may be multiplexed and amplified in one mixing amplifier. Two mixing amplifier configurations are available: EMR Models 4960-01 and 4960-02. Both units are identical except for the output circuitry. The Model 4960-01 Mixing Amplifier is a single-ended output unit with the output voltage referenced to ground. The Model 4960-02 Mixing Amplifier contains an isolation transformer at the unit output which provides a double-ended, balanced output.

All components of the mixing amplifier are contained on a plug-in type printed-circuit card. An eighteen pin male connector is printed on the card for all input and output connections. The mixing amplifier is an operational amplifier circuit which provides high output current capability to drive low-impedance loads.

Information pertaining to EMR Model 4960-03 Mixing Amplifier is contained in separate MSFN manual ME-2615.

2. SPECIFICATIONS

The following paragraphs contain electrical, physical, and environmental specifications for the Models 4960-01 and 4960-02 Mixing Amplifiers. The specifications apply to both mixing amplifiers except where specified.

2.1 Electrical Specifications:

a. Input Impedance: Less than 100 ohms.

b. Frequency Range: 100 CPS to 100 Kc.

c. Frequency Response: For 4960-01, equal to or less than 0.5 Db from 100 CPS to 100 Kc. For 4960-02, equal to or less than 1.0 Db from 100 CPS to 100 Kc.

d. Gain: Maximum channel gain is greater than $50,000/R_S$ at room temperature. R_S is the equivalent source resistance in ohms. Gain is adjustable to a minimum of $5000/R_S$ with the gain adjust control.

e. Gain Stability: When R_S jas a temperature coefficient of ±50 PPM/°C or better, the channel gain is stable within ±2% of the value at an ambient room temperature of +25°C.

EMR MODEL 4960

MIXING AMPLIFIER

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All components of the mixing amplifier are contained on a plug-in type printed-circuit card. An eighteen pin male connector is printed on the card for all input and output connections. The mixing amplifier is an operational amplifier circuit which provides high output current capability to drive low-impedance loads.

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The following paragraphs contain electrical, physical, and environmental specifications for the Models 4960-01 and 4960-02 Mixing Amplifiers. The specifications apply to both mixing amplifiers except where specified.

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d. Gain: Maximum channel gain is greater than $50,000/R_s$ at room temperature. R_s is the equivalent source resistance in ohms. Gain is adjustable to a minimum of $5000/R_s$ with the gain adjust control.

e. Gain Stability: When R_s has a temperature coefficient of ±50 PPM/°C or better, the channel gain is stable within ±2% of the value at an ambient room temperature of +25°C.

f. Output Load Impedance: Any capacitive load can be driven without instability, provided that output current capability is not exceeded. The unit cannot be damaged by an output short circuit.

g. Maximum Output Voltage: 8.0 volts peak-to-peak, open circuit.

h. Maximum Output Current: 40 milliamperes, peak.

i. Output Impedance: For Model 4960-01, 50 ohms ±20% resistive load. Model 4960-02, 600 ohms ±20% (balanced output).

j. Harmonic Distortion: With a sinusoidal input signal, and the unit operating with 1V RMS output voltage and loaded with 50 ohms, the RMS value of the harmonics, measured at the output is equal to or less than 0.5%.

k. Intermodulation Distortion: With two equal amplitude sinusoidal signals of different frequencies applied to the unit, the RMS value of any sum or difference frequency within the frequency range is equal to or less than 0.5% of the sum of the RMS values of the two signal outputs.

l. Power Input Required: Plus and minus 18.8-volts DC regulated, 30 milliamperes.

2.2 Physical Specifications:

a. Length: 5-3/8 inches.

b. Width: 3-7/8 inches.

2.3 Environmental Specifications:

The mixing amplifier shall operate at temperatures between 0°C and +52°C without degradation of performance.

3. INITIAL ADJUSTMENT

The initial adjustment of the EMR Models 4960-01 and 4960-02 Mixing Amplifiers consists of setting the multiplexed output voltage to the desired level. Perform the initial adjustment as follows:

a. Connect the appropriate load to the mixing amplifier output. Output load is determined by particular system application requrements.

b. Apply appropriate input multiplex. Input multiplex is determined by particular system application requirements.

c. Adjust the output voltage level as follows:

1. When adjusting the Model 4960-01, connect an RMS voltmeter between TP1 and ground. Adjust potentiometer R8 for the desired level.

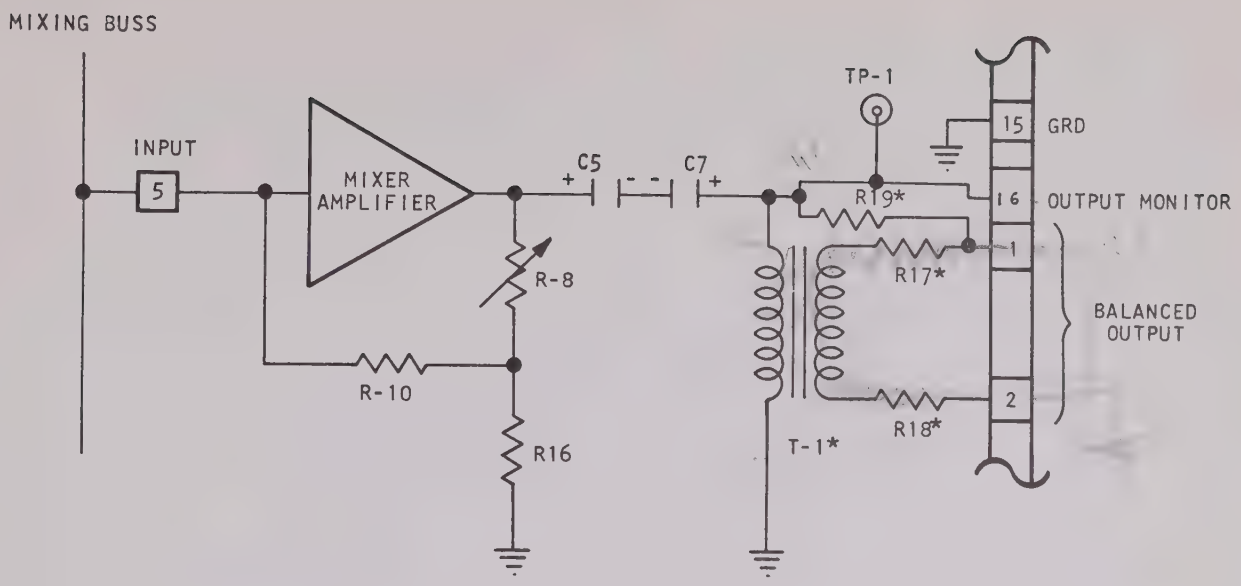
2. When adjusting the Model 4960-02, extend the unit from the mounting drawer using a test adapter, and connect an RMS voltmeter between pins 1 and 2 on the unit connector. Adjust potentiometer R8 for the desired level.

4. THEORY OF OPERATION

This paragraph provides the functional theory of operation for the Models 4960-01 and 4960-02 Mixing Amplifiers. The theory of operation is discussed with reference to the block diagram, Figure 1, and schematic diagram, Figure 2. The theory discussion applies to both the Models 4960-01 and 4960-02 Mixing Amplifiers except where noted.

The mixing amplifier is an operational amplifier which linearly multiplexes the outputs of ground based VCO's and amplifies the composite signal for driving recording or demultiplexing instruments. The input signal, comprised of FM subcarrier frequencies from VCO's, is applied to the operational amplifier circuit consisting of transistors Q1 through Q6. Transistors Q1 and Q2 comprise a differential amplifier stage. The in-phase differential amplifier output, collector of Q2, is applied through emitter-follower Q3 to inverter amplifier stage Q4. Transistor Q4 inverts, and amplifies the multiplexed signal and applies the out-of-phase signal to complementary emitter-followers Q5 and Q6. The out-of-phase signal is also coupled back through frequency compensating capacitor C2 to the base of Q4. The output from complementary emitter-followers Q5 and Q6 is coupled through series capacitors C5 and C7 and resistor R19 to the Model 4960-01 Mixing Amplifier output, pin 1. Pin 2 is connected to ground. For the Model 4960-02 Mixing Amplifier the Q5/Q6 output is coupled through C5 and C7 to output transformer T1. Transformer T1 provides an isolated, balanced output, across pins 1 and 2, which is floating from ground. Capacitors C5 and C7 provide DC isolation from the external equipments being driven by the mixing amplifier.

The operational amplifier feed-back loop is completed by coupling the Q5/Q6 output through potentiometer R8 and resistor R10 to the amplifier input. Potentiometer R8 adjusts the gain of the operational amplifier by controlling the magnitude of the out-of-phase signal fed back to the input stage. Potentiometer R5 in the emitter circuit of transistors Q1 and Q2 is provided for balancing conduction in the two sides of the differential amplifier.



NOTES:

* FOR 4960-01, THE OUTPUT IS APPLIED THROUGH R19 TO CONNECTOR PIN 1, PIN 2 IS GROUNDED. TRANSFORMER T1 AND RESISTORS R17 AND R18 ARE NOT INCLUDED.

FOR 4960-02, THE BALANCED OUTPUT, FLOATING FROM GROUND, IS TAKEN ACROSS CONNECTOR PINS 1 AND 2. RESISTOR R19 IS REMOVED AND TRANSFORMER T1 AND RESISTORS R17 AND R18 ARE INCLUDED.

EMR DRAWING CONTROL NO. 4960-001.

Figure 1. Block Diagram, Models 4960-01 and 4960-02 Mixing Amplifiers

5. MAINTENANCE

This paragraph contains information to aid in troubleshooting and maintenance of the Model 4960 Mixing Amplifier. The information is used in conjunction with the theory of operation in Paragraph 4, so that maintenance may be performed with maximum efficiency.

In the event a malfunction occurs, the following general method of troubleshooting and repairing is recommended:

a. Perform visual inspection (refer to Paragraph 5.1).

b. Extend mixing amplifier from mounting drawer using card extender and troubleshoot by checking transistor voltages (refer to Paragraph 5.2), with reference to the schematic diagram shown in Figure 2, and component location diagram shown in Figure 3.

c. After defective component is located, refer to the parts list for component description (refer to Paragraph 6).

d. After repair is accomplished, perform calibration procedure (refer to Paragraph 5.3).

5.1 Inspection

The Model 4960 Mixing Amplifier should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following inspection should be performed periodically as a means of preventive maintenance or, if a malfunction occurs, to aid in isolating the trouble.

a. Inspect mixing amplifier for mechanical damage and for component discoloration caused by overheating.

b. Inspect mating connector in mounting drawer for signs of damage or potential trouble spots.

5.2 Transistor Voltage Measurements

A tabular listing of typical transistor voltages for the mixing amplifier is provided in Table 1.

5.3 Calibration Procedure

The calibration procedure for the mixing amplifier is as follows:

a. Apply power to mixing amplifier.

b. Remove all input signals to mixing amplifier. (Input to be grounded through 51K resistor.)

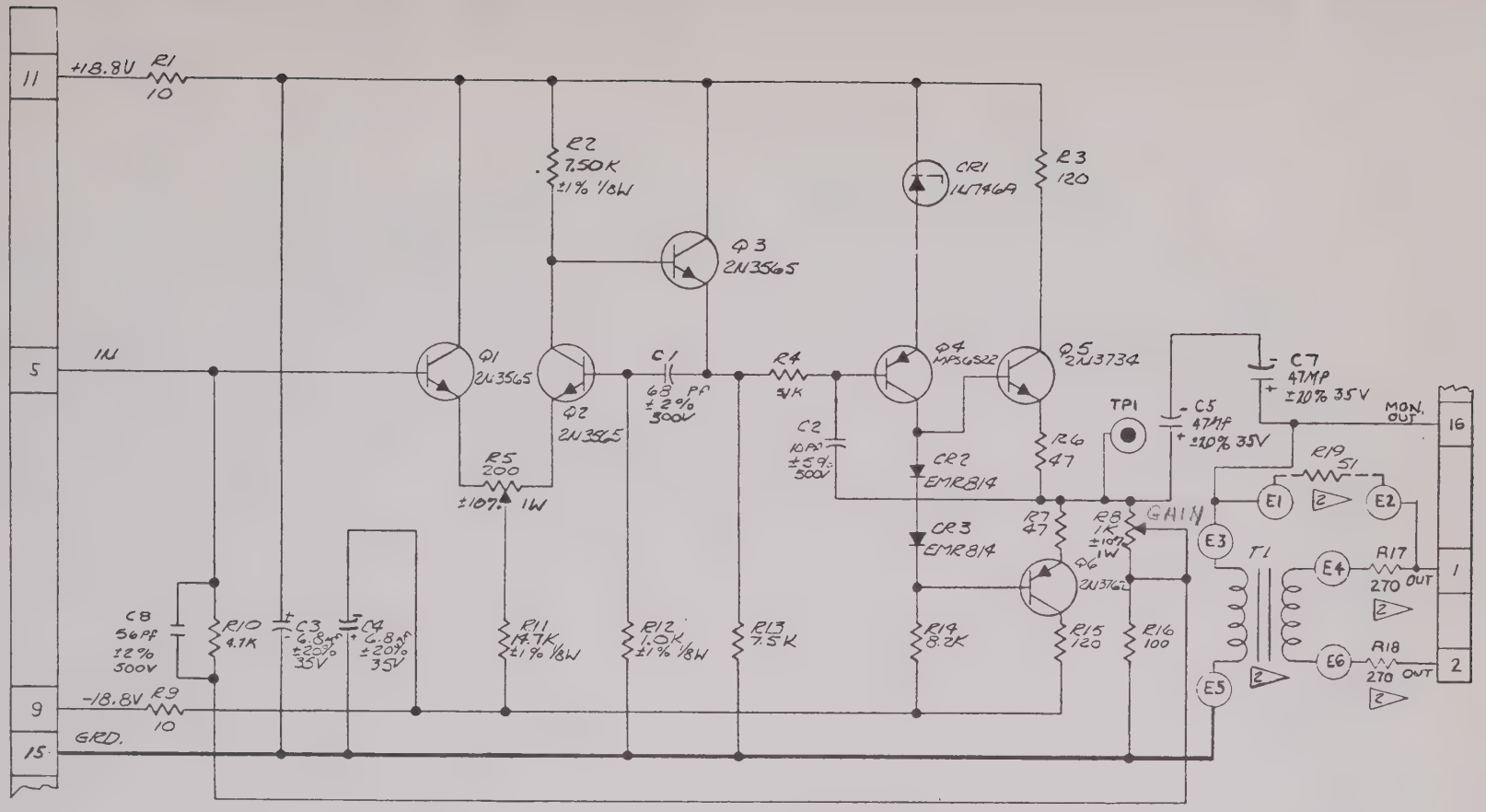
c. Connect an RMS voltmeter between TP1 and ground.

d. Adjust potentiometer R5 for a 0-volt indication on RMS voltmeter.

e. Adjust mixing amplifier output voltage level as outlined in Paragraph 3, Initial Adjustment.

6. PARTS LIST

The Model 4960 Mixing Amplifier parts list is provided in Table 2. Parts information is presented in tabular form and is keyed to the circuit symbols of components on the component location diagram, Figure 3.

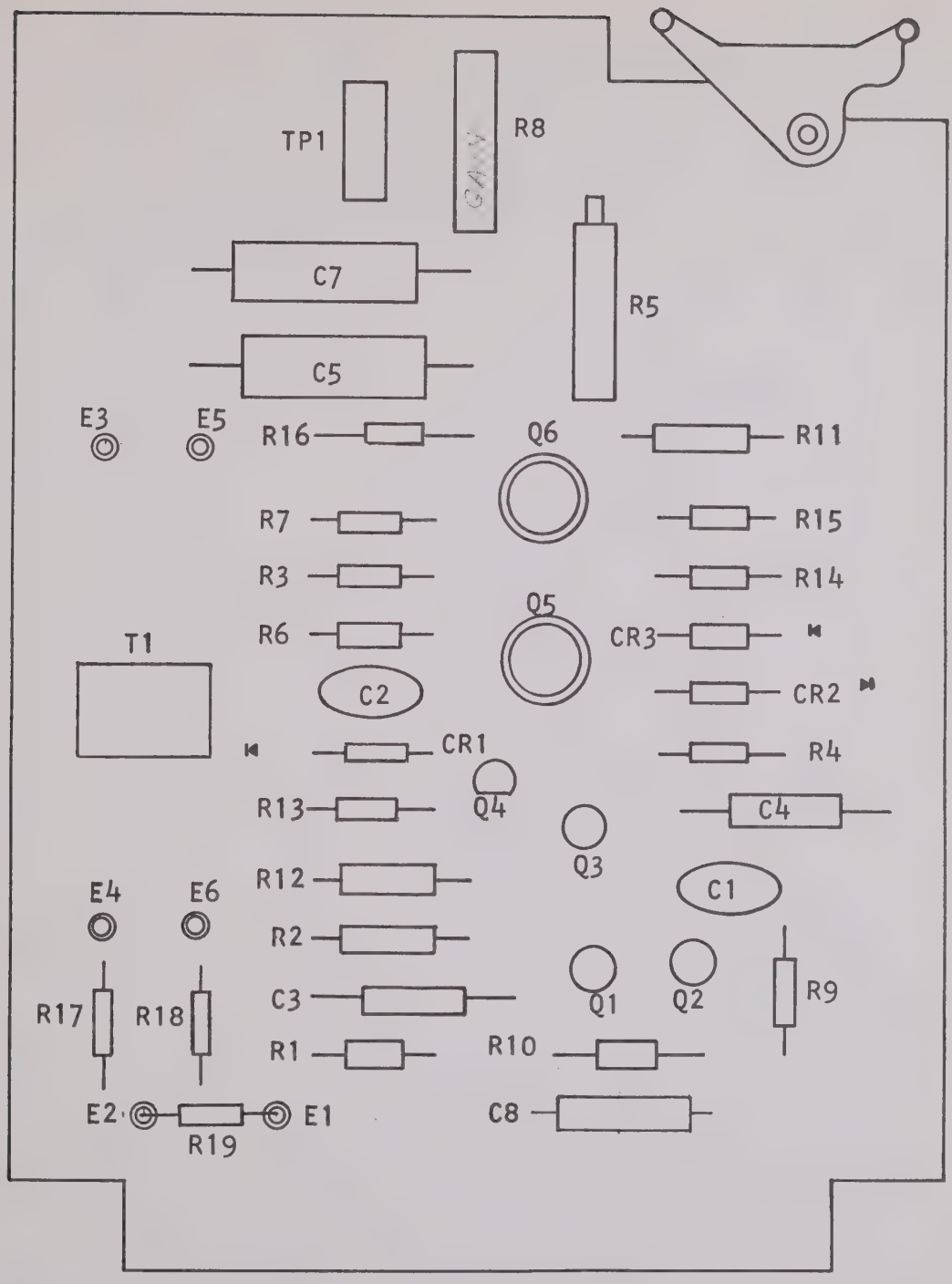


NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000) AND ARE ±5%, 1/4W UNLESS OTHERWISE SPECIFIED.
2. FOR MODEL 4960-01, JUMPER E5 TO E6, JUMPER E6 TO CONNECTOR PIN 2, AND CONNECT R19 BETWEEN E1 AND E2. ELIMINATE T1, R17, AND R18.

   FOR MODEL 4960-02, INSTALL T1, R17, AND R18. ELIMINATE R19, E5 TO E6 JUMPER, AND E6 TO PIN 2 JUMPER.
3. EMR DRAWING NO. C6901.

Figure 2. Schematic Diagram, Models 4960-01 and 4960-02 Mixing Amplifiers



EMR DRAWING CONTROL NO. 4960-002

Figure 3. Component Location Diagram, Models 4960-01 and 4960-02 Mixing Amplifiers

The parts list table is divided into the following columns: Ref. Desig., providing the reference designation of the component; Description, providing a complete description of the item; Manufacturer, providing the name and manufacturer's part number where applicable. For some components, the Manufacturer column contains an EMR source control number. These components are identified by an asterisk in the Name portion of the column. In the Part No. column, a coded number references an approved vendor for that item in Table 3, Approved Vendor List.

Table 1. Transistor Voltages

Transistor	E	B	C
Q1	-.6	0	+18.8
Q2	-.6	0	+16.
Q3	+15.5	+16.	+18.8
Q4	+16.2	+15.5	+.6
Q5	0	+.6	+18.8
Q6	0	-.6	-18.8

Table 2. Parts List, Models 4960-01 and 4960-02 Mixing Amplifiers

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
	MODEL 4960 MIXING AMPLIFIER ASSEMBLY	EMR	6893
CR1	DIODE, 1N746A	*	642
CR2	DIODE	*	814
CR3	DIODE	*	814
C1	CAPACITOR, 68 Pf ±2%, 300V	*	600
C2	CAPACITOR, 10 Pf ±5%, 500V	*	600
C3	CAPACITOR, 6.8 µf ±20%, 35V	*	601
C4	CAPACITOR, 6.8 µf ±20%, 35V	*	601
C5	CAPACITOR, 47 µf ±20%, 35V	*	601
C7	CAPACITOR, 47 µf ±20%, 35V	*	601
C8	CAPACITOR, 56 Pf ±2%, 500V	*	600
Q1	TRANSISTOR	Motorola	2N3565
Q2	TRANSISTOR	Motorola	2N3565
Q3	TRANSISTOR	Motorola	2N3565
Q4	TRANSISTOR	Motorola	MPS 6522
Q5	TRANSISTOR	Motorola	2N3734
Q6	TRANSISTOR	Motorola	2N3762
R1	RESISTOR, 10Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 100J
R2	RESISTOR, 7.50K ±1%, 1/8W	*	625
R3	RESISTOR, 120Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 121J
R4	RESISTOR, 5.1K ±5%, 1/4W	MIL-R-11/8	RC07GF 512J
R5	RESISTOR, 200Ω ±10%, 1W	Amphenol	2600P-201
R6	RESISTOR, 47Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 470J
R7	RESISTOR, 47Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 470J
R8	RESISTOR, 1K ±10%, 1W	Amphenol	2600P-102
R9	RESISTOR, 10Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 100J
R10	RESISTOR, 4.7K ±5%, 1/4W	MIL-R-11/8	RC07GF 472J
R11	RESISTOR, 14.7K ±1%, 1/8W	*	625
R12	RESISTOR, 1.0K ±1%, 1/8W	*	625
R13	RESISTOR, 7.5K ±5%, 1/4W	MIL-R-11/8	RC07GF 752J
R14	RESISTOR, 8.2K ±5%, 1/4W	MIL-R-11/8	RC07GF 822J

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 3.

Table 2 (Cont'd.). Parts List, Models 4960-01 and 4960-02 Mixing Amplifiers

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R15	RESISTOR, 120Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 121J
R16	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R17	RESISTOR, 270Ω ±5%, 1/4W (Used on Model 4960-02 only)	MIL-R-11/8	RC07GF 271J
R18	RESISTOR, 270Ω ±5%, 1/4W (Used on Model 4960-02 only)	MIL-R-11/8	RC07GF 271J
R19	RESISTOR, 51Ω ±5%, 1/4W (Used on Model 4960-01 only)	MIL-R-11/8	RC07GF 510J
T1	TRANSFORMER (Used on Model 4960-02 only)	EMR	6879

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 3.

Table 3. Approved Vendors List

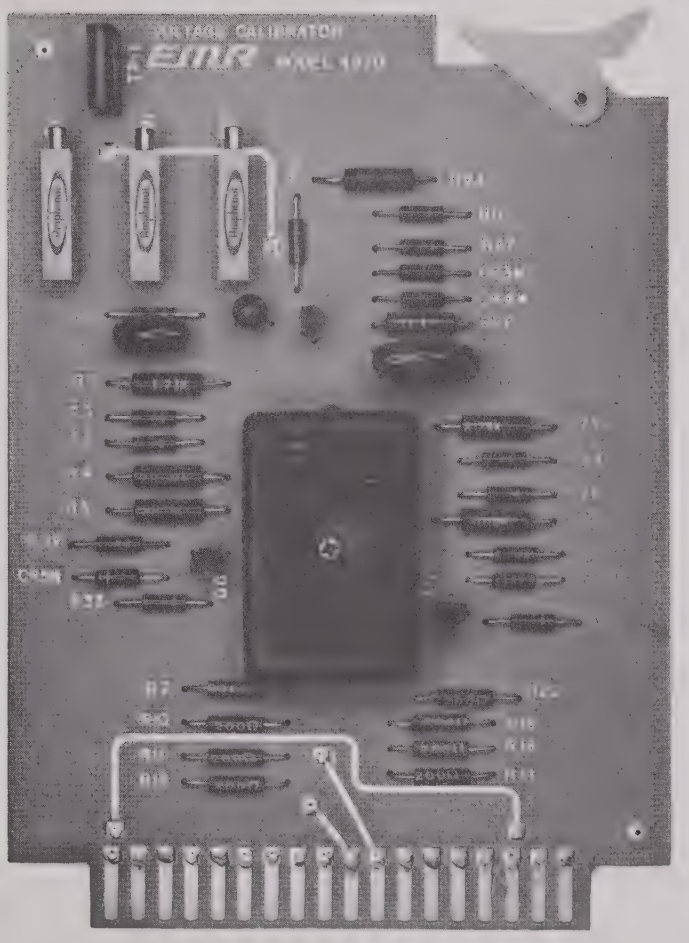
EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
600	Electro-Motive Mfg. Co.	DM Series
	Arco Electronics	DM Series
601	Kemet Company	J Series
	Sprague Electric Co.	CS13, 150D
	Mallory Capacitor Co.	TAS Series
	U.S. Semcor	TS-1 TS4
619	Alpha Wire Corp	
	Columbia Wire & Supply Co.	
621	Dale Electronics	RS-2C
	Sage Electronics	SA2W
	Ward-Leonard	3SX
	Mepco, Inc.	HT120
623	Dale Electronics	RS-5
	Ohmite	RW67
	Sage Electronics	1550S
624	IRC	EM
	Mepco	FE-10
	Dale	MF-1/10
	Sprague	416E
625	IRC	MEA
	Mepco	FE-12
	Dale Electronics	MF
	Ward-Leonard	WL60
	Electra	MF5
	Sprague	418E
639	Clevite Semiconductor	1N457
	Erie Tech. Prod.	1N457
	Fairchild Semiconductor	1N457
	Hughes Semiconductor	1N457
	Continental Device Corp.	1N457
	Raytheon	1N457
	Sylvania	1N457
	Transitron	1N457
	General Instrument	1N457
642	General Instrument	1N746A through 1N759A
	Hoffman	1N746A through 1N759A
	Motorola	1N746A through 1N759A
	Continental Device	1N746A through 1N759A
	Texas Instrument	1N746A through 1N759A
	Transitron	1N746A through 1N759A
	TRW	1N746A through 1N759A

Table 3 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
642	Western	1N746A through 1N759A
(Cont'd.)	International Rectifier	1N746A through 1N759A
	Hughes	1N746A through 1N759A
648	General Instrument	2N1309
	Texas Instrument	2N1309
	RCA	2N1309
649	General Instrument	2N404
	Texas Instrument	2N404
	RCA	2N404
658	Texas Instrument	2N2412
663	Transitron	SG-22
	Continental Device	CD1117
	Sylvania	DG472
666	General Electric	NPN
	General Instrument	NPN
	National Semiconductor	NPN
	Fairchild	NPN
	Motorola	NPN
671	General Electric	2N708
	General Instrument	2N708
	Texas Instrument	2N708
	RCA	2N708
	Motorola	2N708
	National Semiconductor	2N708
673	Continental Device	1N3064
	General Electric	1N3064
	Raytheon	1N3064
	Sylvania	1N3064
	Texas Instrument	1N3064
	Transitron	1N3064
694	Hughes	2N1131
	Motorola	2N1131
	Fairchild	2N1131
	Transitron	2N1131
	Texas Instrument	2N1131
800	Admiral Plastics	
	Delbert Blinn	
	Milton Ross	
	Thermalloy	
	Perfection Mica	
800-1	Milton Ross	
	Thermalloy	

Table 3 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
801	Motorola	2N2501
	General Instrument	2N2501
809	Electro-Motive Mfg. Co.	MPD Series
814	Fairchild	
	Western Semiconductors	
829	Texas Instrument	2N1308
	RCA	2N1308
834	Daystrom	
903	Fairchild	FA2411
905	Electro Cube, Inc.	
910	Continental Device	1N965
	Fairchild	1N965
	Motorola	SZ50548
919	Ledex, Inc.	
920	Ledex, Inc.	



EMR MODEL 4970

NINE-POINT VOLTAGE CALIBRATOR

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EMR MODEL 4970

NINE-POINT VOLTAGE CALIBRATOR

1. DESCRIPTION

The EMR Model 4970 Nine-Point Voltage Calibrator supplies precision voltages for calibrating ground-based voltage-controlled oscillators (VCO's) used in FM telemetry systems. All components of the calibrator are contained on a plug-in type printed-circuit card. An eighteen pin male connector is printed on the card for all input and output connections. The calibrator is a self-contained unit except for an output voltage selector switch mounted on the front panel of the mounting drawer.

Functional circuitry of the calibrator includes: (1) a precision voltage selector circuit which establishes calibration output voltage, and (2) an operational amplifier circuit which provides isolation and current drive capabilities for the calibration output voltage.

2. SPECIFICATIONS

The following paragraphs contain electrical, physical, and environmental specifications for the EMR Model 4970 Nine-Point Voltage Calibrator.

2.1 Electrical Specifications:

a. Calibration Voltages: -10, -7.5, -5, -2.5, 0, +2.5, +5, +7.5, and +10 volts DC into a maximum load of 1000 ohms shunted by 0.01 μf capacitance.

b. Output Voltage Accuracy: Within ±5 microvolts at 0-volt level and within 0.2% of any other setting.

c. Output Voltage Stability: After a 15-minute warm-up, the output voltage shall be stable within 0.05% during an 8-hour period.

d. Power Input Required: Plus and minus 18.8 volts DC ±5%, regulated, 25 milliamperes.

2.2 Physical Specifications:

a. Length: 5-3/8 inches.

b. Width: 3-7/8 inches.

2.3 Environmental Specifications:

The calibrator shall operate at temperatures between 0°C and +52°C without degradation of performance.

3. THEORY OF OPERATION

This paragraph provides the functional theory of operation for the Model 4970 Nine-Point Voltage Calibrator. The calibrator theory of operation is discussed with reference to the block diagram, Figure 1, and schematic diagram, Figure 2.

The calibrator circuitry consists of a precision voltage selector circuit and an operational amplifier circuit. The voltage selector circuit establishes the calibration output voltage. The operational amplifier circuit provides isolation and current drive capabilities for the selected calibration output voltage. A discussion of each circuit is contained in the following paragraphs.

3.1 Voltage Selector Circuit

The voltage selector circuit consists of two voltage dividers. One voltage divider operates from a regulated +18.8-volt DC input and the other from a regulated -18.8-volt DC input. Each voltage divider consists of a constant current generator, a reference diode, and a multi-tapped resistive network.

The constant current generators maintain a constant current through reference diodes CR1 and CR2, in the respective resistive networks in parallel with CR1 and CR2. Diodes CR1 and CR2 provide a stable 11.7-volt source voltage for the respective resistive networks. Taps from the resistive networks are wired to terminals on the calibrator connector. These terminals are wired to an external voltage selector switch which permits selection of the calibration output voltage.

Variable resistors, R1 and R21, in the resistive networks are used for precision adjustment of the calibration voltage.

3.2 Operational Amplifier Circuit

The operational amplifier circuit is a unity-gain amplifier consisting of transistors Q1 through Q5. The input stage, a two-transistor-module, Q4A and Q4B, is a differential amplifier. The selected calibration voltage is applied to the base of Q4A as the reference voltage. The high input impedance of this stage minimizes the loading effect on the reference voltage input. The reference voltage level is inverted by Q4B and applied to the base of Q2. Transistors Q1 and Q2 comprise a second differential amplifier which inverts and amplifies the reference voltage and applies it through complementary emitter-followers Q3 and Q5 to the calibrator output.

Emitter-followers Q3 and Q5 provide a high current and low impedance output for calibrating groups of VCO's. The low impedance output prevents variations in the calibration output voltage when different numbers of VCO's are being driven.

The amplifier gain is limited at unity by completing the feedback loop from the amplifier output to the base of the differential amplifier input stage Q4B. Potentiometer R15, in the emitter circuit of transistor Q4, is provided for balancing conduction in the two sides of the input differential amplifier.

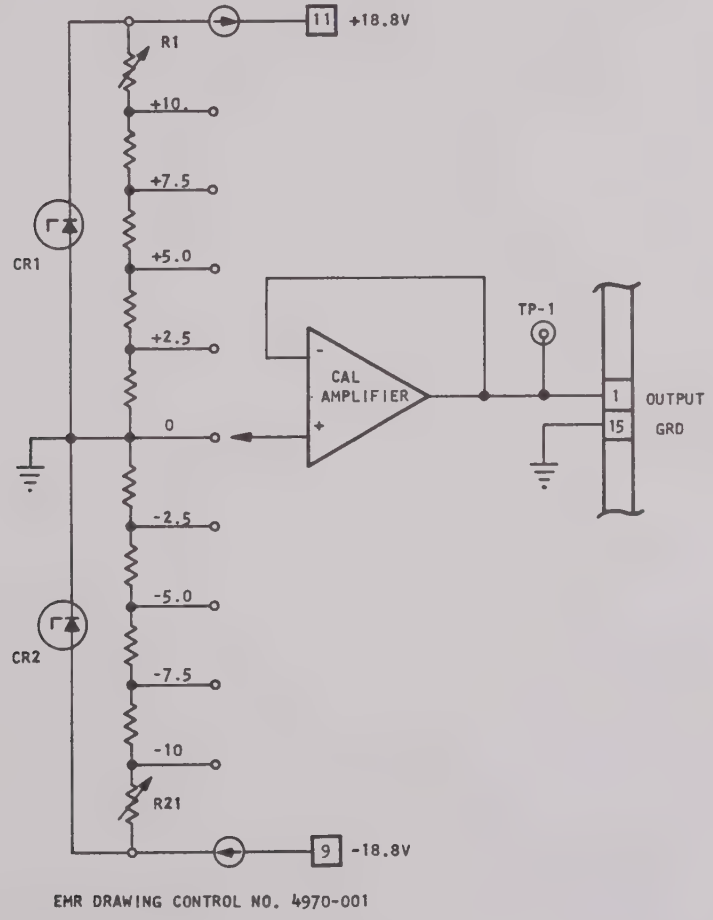


Figure 1. Block Diagram, Model 4970 Nine-Point Voltage Calibrator

4. MAINTENANCE

This paragraph contains information to aid in troubleshooting and maintenance of the EMR Model 4970 Nine-Point Voltage Calibrator. The information is used in conjunction with the theory of operation in Paragraph 3, so that maintenance may be performed with maximum efficiency.

In the event a malfunction occurs, the following general method of trouble-shooting and repairing is recommended:

a. Perform visual inspection (refer to Paragraph 4.1.)

b. Extend calibrator from mounting drawer using card extender and troubleshoot by checking transistor voltages (refer to Paragraph 4.2), with reference to the schematic diagram shown in Figure 2, and component location diagram shown in Figure 3.

c. After defective component is located, refer to the parts list for component description (refer to Paragraph 5.)

d. Once repair is accomplished, perform calibration procedure (refer to Paragraph 4.3.)

4.1 Inspection

The Model 4970 Nine-Point Voltage Calibrator should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following inspection should be performed periodically as a means of preventive maintenance or, if a malfunction occurs, to aid in isolating the trouble.

a. Inspect calibrator for mechanical damage and for component discoloration caused by overheating.

b. Inspect mating connector in mounting drawer for signs of damage or potential trouble spots.

4.2 Transistor Voltage Measurements

A tabular listing of typical transistor voltages for the calibrator is provided in Table 1. Each transistor terminal voltage is listed three times, corresponding to positioning of the external voltage selector switch. The first listing provides transistor terminal voltages with the external voltage selector switch in the +10V position. The second and third listings provides transistor terminal voltages with the external voltage selector switch in the 0V and -10V positions, respectively.

4.3 Calibration Procedure

The calibration procedure for the calibrator is as follows:

a. Apply power to calibrator.

b. Connect differential DC voltmeter,accurate to 0.01%, between TP1 and ground.

c. Position the external voltage selector switch to 0V.

d. Adjust potentiometer R15 for a 0-volt indication.

e. Position external voltage selector switch to +10V.

f. Adjust potentiometer R1 for a +10-volt ±5-millivolt indication.

g. Position external voltage selector switch to -10V.

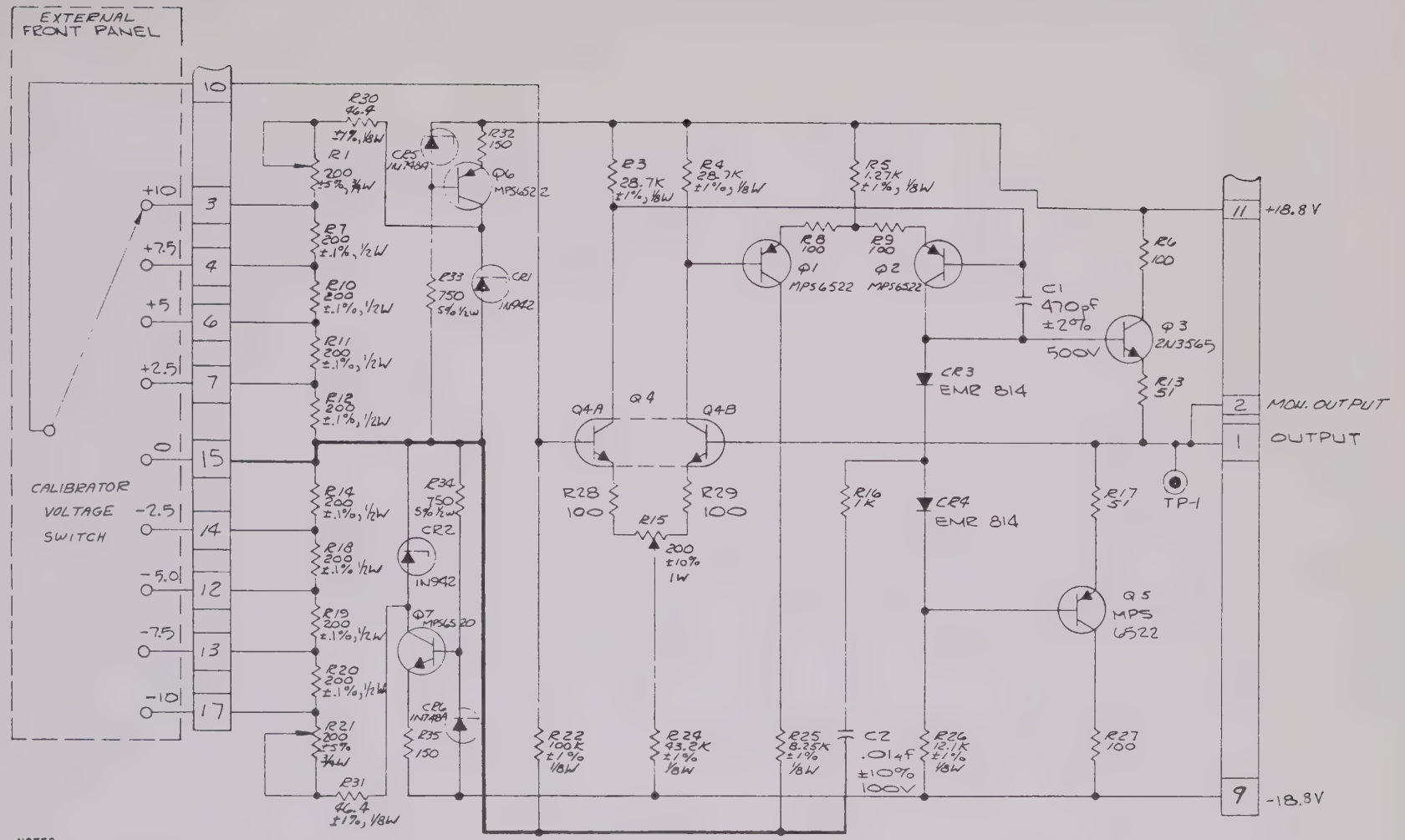
h. Adjust potentiometer R21 for a -10-volt ±5-millivolt indication.

i. Position the external voltage selector switch to the remaining positions and monitor the calibrator output for the corresponding indication. All output voltages shall be within ±0.2% of the selected output.

5. PARTS LIST

The Model 4970 Nine-Point Voltage Calibrator parts list is provided in Table 2. Parts information is presented in tabular form and is keyed to the circuit symbols of components on the component location diagram, Figure 3.

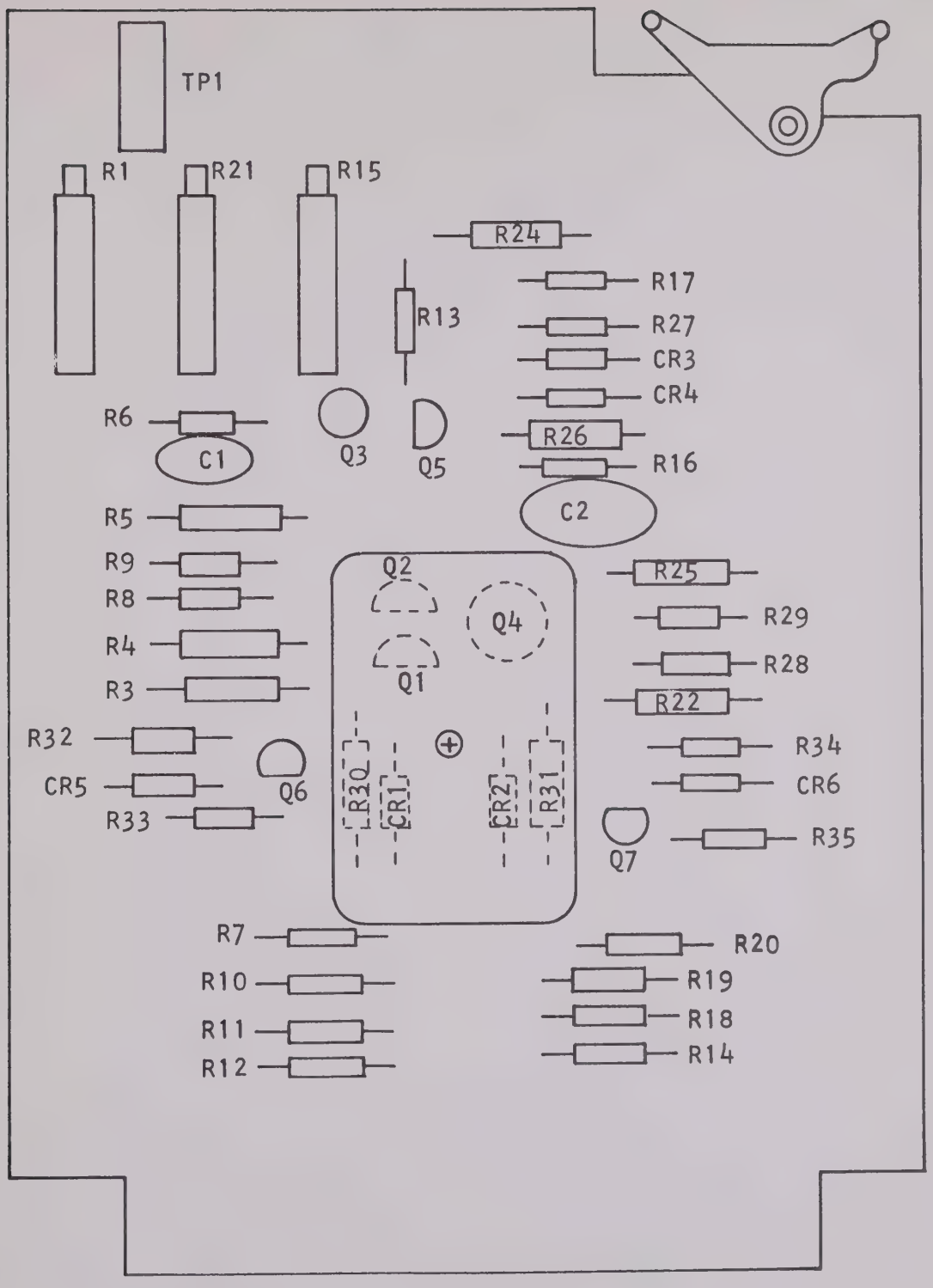
The parts list is divided into the following columns: Ref. Desig., providing the reference designation of the component; Description, providing a complete description of the item; Manufacturer, providing the name and manufacturer's part number where applicable. For some components, the Manufacturer column contains an EMR source control number. These components are identified by an asterisk in the Name portion of the column. In the Part No. column, a coded number references an approved vendor for that item in Table 3, Approved Vendor List.



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000) ±5%, 1/4W, UNLESS OTHERWISE SPECIFIED.
2. EMR DRAWING NO. 6904

Figure 2. Schematic Diagram, Model 4970 Nine-Point Voltage Calibrator



EMR DRAWING CONTROL NO. 4970-002

Figure 3. Component Location Diagram, Model 4970 Nine-Point Voltage Calibrator

Table 1. Transistor Voltages

Voltage Calibrator +10 Volt Input			
Transistor	E	B	C
Q1	+13.5	+12.9	+13.5
Q2	+13.5	+12.9	+10.6
Q3	+10.0	+10.6	+18.8
Q4A	+9.4	+10.0	+12.8
Q4B	+9.4	+10.0	+12.8
Q5	+10.0	+9.4	-18.8
Q6	+15.5	+14.9	+12.
Q7	-15.5	-14.9	-12.

Voltage Calibrator 0 Volt Input			
Transistor	E	B	C
Q1	+14.5	+13.9	+14.5
Q2	+14.5	+13.9	+.6
Q3	0	+.6	+18.8
Q4A	-.56	0	+13.9
Q4B	-.56	0	+13.9
Q5	0	-.6	-18.8
Q6	+15.5	+14.9	+12.0
Q7	-15.5	-14.9	-12.0

Voltage Calibrator -10 Volt Input			
Transistor	E	B	C
Q1	+16.8	+16.0	+7.2
Q2	+16.8	+16.0	-9.4
Q3	-10.0	-9.4	+18.8
Q4A	-10.6	-10.0	+16.2
Q4B	-10.6	-10.0	+16.2
Q5	-10.0	-10.6	-18.8
Q6	+15.5	+14.9	+12.
Q7	-15.5	-14.9	-12.

Table 2. Parts List, Model 4970 Nine-Point Voltage Calibrator

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
	MODEL 4970 VOLTAGE CALIBRATOR ASSEMBLY	EMR	6902
CR1	DIODE	Motorola	1N942
CR2	DIODE	Motorola	1N942
CR3	DIODE	*	814
CR4	DIODE	*	814
CR5	DIODE,1N748A	*	642
CR6	DIODE,1N748A	*	642
C1	CAPACITOR, 470 Pf ±2%, 500V	*	600
C2	CAPACITOR, 0.01 μf ±10%, 100V	*	809
Q1	TRANSISTOR	Motorola	MPS 6522
Q2	TRANSISTOR	Motorola	MPS 6522
Q3	TRANSISTOR	Fairchild	2N3565
Q4	TRANSISTOR	*	666
Q5	TRANSISTOR	Motorola	MPS 6522
Q6	TRANSISTOR	Motorola	MPS 6522
Q7	TRANSISTOR	Motorola	MPS 6520
R1	RESISTOR, 200Ω ±5%, 3/4W	Clarostat	76JA-3
R3	RESISTOR, 28.7K ±1%, 1/8W	*	625
R4	RESISTOR, 28.7K ±1%, 1/8W	*	625
R5	RESISTOR, 1.27K ±1%, 1/8W	*	625
R6	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R7	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R8	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R9	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R10	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R11	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R12	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R13	RESISTOR, 51Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 510J
R14	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R15	RESISTOR, 200Ω ±10%, 1W	Amphenol	2600P-201
R16	RESISTOR, 1K ±5%, 1/4W	MIL-R-11/8	RC07GF 102J
R17	RESISTOR, 51Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 510J
R18	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R19	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2
R20	RESISTOR, 200Ω ±.1%, 1/2W	Dale	RS 1/2

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 3.

Table 2 (Cont'd.). Parts List, Model 4970 Nine-Point Voltage Calibrator

REF. DESIG.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R21	RESISTOR, 200Ω ±5%, 3/4W	Clarostat	76JA-3
R22	RESISTOR, 100K ±1%, 1/8W	*	625
R24	RESISTOR, 43.2K ±1%, 1/8W	*	625
R25	RESISTOR, 8.25K ±1%, 1/8W	*	625
R26	RESISTOR, 12.1K ±1%, 1/8W	*	625
R27	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R28	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R29	RESISTOR, 100Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 101J
R30	RESISTOR, 46.4Ω ±1%, 1/8W	*	625
R31	RESISTOR, 46.4Ω ±1%, 1/8W	*	625
R32	RESISTOR, 150Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 151J
R33	RESISTOR, 750Ω ±5%, 1/2W	MIL-R-11/3	RC20GF 751J
R34	RESISTOR, 750Ω ±5%, 1/2W	MIL-R-11/3	RC20GF 751J
R35	RESISTOR, 150Ω ±5%, 1/4W	MIL-R-11/8	RC07GF 151J

* Coded number in Part No. column identifies approved manufacturer and part number located in Table 3.

Table 3. Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
600	Electro-Motive Mfg. Co.	DM Series
	Arco Electronics	DM Series
601	Kemet Company	J Series
	Sprague Electric Co.	CS13, 150D
	Mallory Capacitor Co.	TAS Series
	U.S. Semcor	TS-1 TS4
619	Alpha Wire Corp	
	Columbia Wire & Supply Co.	
621	Dale Electronics	RS-2C
	Sage Electronics	SA2W
	Ward-Leonard	3SX
	Mepco, Inc.	HT120
623	Dale Electronics	RS-5
	Ohmite	RW67
	Sage Electronics	1550S
624	IRC	EM
	Mepco	FE-10
	Dale	MF-1/10
	Sprague	416E
625	IRC	MEA
	Mepco	FE-12
	Dale Electronics	MF
	Ward-Leonard	WL60
	Electra	MF5
	Sprague	418E
639	Clevite Semiconductor	1N457
	Erie Tech. Prod.	1N457
	Fairchild Semiconductor	1N457
	Hughes Semiconductor	1N457
	Continental Device Corp.	1N457
	Raytheon	1N457
	Sylvania	1N457
	Transitron	1N457
	General Instrument	1N457
642	General Instrument	1N746A through 1N759A
	Hoffman	1N746A through 1N759A
	Motorola	1N746A through 1N759A
	Continental Device	1N746A through 1N759A
	Texas Instrument	1N746A through 1N759A
	Transitron	1N746A through 1N759A
	TRW	1N746A through 1N759A

Table 3 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
642 (Cont'd.)	Western	1N746A through 1N759A
	International Rectifier	1N746A through 1N759A
	Hughes	1N746A through 1N759A
648	General Instrument	2N1309
	Texas Instrument	2N1309
	RCA	2N1309
649	General Instrument	2N404
	Texas Instrument	2N404
	RCA	2N404
658	Texas Instrument	2N2412
663	Transitron	SG-22
	Continental Device	CD1117
	Sylvania	DG472
666	General Electric	NPN
	General Instrument	NPN
	National Semiconductor	NPN
	Fairchild	NPN
	Motorola	NPN
671	General Electric	2N708
	General Instrument	2N708
	Texas Instrument	2N708
	RCA	2N708
	Motorola	2N708
	National Semiconductor	2N708
673	Continental Device	1N3064
	General Electric	1N3064
	Raytheon	1N3064
	Sylvania	1N3064
	Texas Instrument	1N3064
	Transitron	1N3064
694	Hughes	2N1131
	Motorola	2N1131
	Fairchild	2N1131
	Transitron	2N1131
	Texas Instrument	2N1131
800	Admiral Plastics	
	Delbert Blinn	
	Milton Ross	
	Thermalloy	
	Perfection Mica	
800-1	Milton Ross	
	Thermalloy	

Table 3 (Cont'd.). Approved Vendors List

EMR SOURCE CONTROL NUMBER	VENDOR	TYPE
801	Motorola	2N2501
	General Instrument	2N2501
809	Electro-Motive Mfg. Co.	MPD Series
814	Fairchild	
	Western Semiconductors	
829	Texas Instrument	2N1308
	RCA	2N1308
834	Daystrom	
903	Fairchild	FA2411
905	Electro Cube, Inc.	
910	Continental Device	1N965
	Fairchild	1N965
	Motorola	SZ50548
919	Ledex, Inc.	
920	Ledex, Inc.	

Typeface Specimen Sheet

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